DEPARTMENT OF THE ARMY TECHNICAL MANUAL	TM 95-225
DEPARTMENT OF THE NAVY MANUAL	NAVAIR 16-1-520
DEPARTMENT OF THE AIR FORCE MANUAL	AFMAN 11-225
FEDERAL AVIATION ADMINISTRATION ORDER	8200.1A

UNITED STATES STANDARD FLIGHT INSPECTION MANUAL

MAY 1996

DEPARTMENTS OF THE ARMY, THE NAVY, AND THE AIR FORCE
AND
THE FEDERAL AVIATION ADMINISTRATION

DISTRIBUTION: ZVN-820

Initiated By: AVN-230

The material contained herein was formerly issued as the United States Standard Flight Inspection Manual, dated December 1956.

The second edition incorporated the technical material contained in the United States Standard Flight Inspection Manual and revisions thereto and was issued as the United States Standard Facilities Flight Check Manual, dated December 1960.

The third edition superseded the second edition of the United States Standard Facilities Flight Check Manual; Department of Army technical manual TM-11-2557-25; Department of Navy Manual NAVWEP 16-1-520; Department of the Air Force Manual AFM 55-8; United States Coast Guard Manual CG-317.

The current FAA Order 8200.1A is a revision of the third edition of the United States Standard Flight Inspection Manual, FAA OA P 8200.1; Department of the Army Technical Manual TM 95-225; Department of the Navy Manual NAVAIR 16-1-520; Department of the Air Force Manual AFMAN 11-225; United States Coast Guard Manual CG-317; and is effective upon receipt.

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FOREWORD

The purpose of this manual is to prescribe standardized procedures for the flight inspection of air navigation services. It is not intended as authorization for an agency to assume flight inspection authority over any group of services which are not now under its jurisdiction. Similarly, it carries no designation of responsibility within any agency unless such has been so designated in its usual procedural manner, such as general orders, regulations, etc.

This manual is directive upon all personnel charged with the responsibility for execution of the flight inspection mission, when such personnel or organization is so designated by its agency. Compliance with this manual, however, is not a substitute for common sense and sound judgment. Nothing in this manual shall be construed to relieve flight inspection crews or supervisory personnel of the responsibility of exercising initiative in the execution of the mission, or from taking such emergency action as the situation warrants.

The Federal Aviation Administration will coordinate and provide approved changes to this manual by means of a page revision method. Revised pages will be transmitted by a Federal Aviation Administration Notice. Recommendations concerning changes or additions to the subject material are welcomed and should be forwarded to one of the following addresses;

Chief of Staff, United States Army, Washington, D.C.
Chief of Naval Operations, Navy Department, Washington, D.C.
Chief of Staff, United States Air Force, Washington, D.C.
Commandant, U.S. Coast Guard, 2100 2nd Street, S.W., Washington, D.C. 20593
Administrator, Federal Aviation Administration, Washington, D.C.

This Manual of Flight Inspection Procedures has been officially approved by: Chief of Staff, U.S. Army; Chief of Naval Operations, U.S. Navy; Chief of Staff, U.S. Air Force; Commandant, U.S. Coast Guard; and Administrator of the Federal Aviation Administration.

William H. Williams, Jr.
Program Director of Aviation System Standards

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SECTION 101. INTRODUCTION

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CHAPTER 100. GENERAL

SECTION 101. INTRODUCTION

101.1 PURPOSE. This order contains the policy, procedures, and criteria for flight inspection and certification of air navigation services, including the instrument flight procedures they support. The order applies to the flight inspection of all National Airspace System (NAS) and Department of Defense air navigation services and instrument flight procedures.

101.2 DISTRIBUTION. This order is distributed to selected offices on special mailing list ZVN-820. Distribution within the Department of Defense is handled by the Defense Mapping Agency (DMAODS).

101.3 CANCELLATION. The following directives are canceled:

a. **Handbook OA P 8200.1,** United States Standard Flight Inspection Manual (USSFIM), Department of the Army Technical Manual TM 95-225, Department of the Navy Manual NAVAIR 16-1-520, and Department of the Air Force Manual AFM 55-8, **consolidated reprint dated January 1984 included Changes 1 thru 40.**

b. **OA P 8200.1, Change 41,** dated September 9, 1983.

c. **OA P 8200.1, Change 42,** dated March 27, 1985.

d. **OA P 8200.1, Change 43,** dated October 31, 1985.

e. **OA P 8200.1, Change 44,** dated April 29, 1986.

f. **OA P 8200.1, Change 45,** dated September 10, 1987.

g. **OA P 8200.1, Change 46,** dated January 18, 1991.

h. **OA P 8200.1, Change 47,** dated May 2, 1994.

i. **OA P 8200.1 FSNFO SUP 39,** dated April 15, 1982.

j. **OA P 8200.1 FSNFO SUP 40,** dated June 9, 1982.

k. **OA P 8200.1 AVN SUP 2,** dated May 20, 1983.

l. **Order 8200.35,** Flight Inspection Tolerances and Radio Frequency (RF) Alarm Requirements for Nondirectional Beacons (NDB), dated March 19, 1991.

m. **Order 8200.37,** Periodic Flight Inspection Intervals of ILS Systems, dated January 21, 1994.

n. **Order 8200.38,** Flight Inspection of the Global Positioning System (GPS), dated December 5, 1994.

o. **Order 8200.38A,** Flight Inspection of the Global Positioning System (GPS), dated March 18, 1996.

p. **Order 8240.9C,** VOR/VORTAC System Improvement, dated July 16, 1985.

q. **Order 8240.50,** Flight Inspection of Microwave Landing Systems (MLS), dated January 2, 1990.

r. **GENOT N 8200.50,** Change in Order 8200.37, Periodic Flight Inspection Intervals of ILS Facilities, dated 3/21/94.

s. **GENOT N 8200.52,** Change in VOR/TACAN/VORTAC/DF Requirements Due to the Semi-Automatic Flight Inspection (SAFI) Program, dated 7/29/94.

t. **GENOT N 8200.53,** Correction to Change 47 to OA P 8200.1, dated September 15, 1994.

u. **GENOT N 8200.54,** Mode S Flight Inspection Requirements, dated March 14, 1995.

v. GENOT N 8200.55, Change in Flight Inspection Requirements for Glide Slope Facilities NOTAMED in Accordance with Order 6750.49, Maintenance of Instrument Landing System (ILS) Facilities, Paragraph 1450 and Table 5-4, dated April 25, 1995.

w. GENOT N 8200.56, Change in Visual Glide Slope Indicator (VGSI) Flight Inspection Checklist and Reporting Requirements, dated April 25, 1995.

x. GENOT N 8200.57, Change in Flight Inspection of 75 MHz Marker Beacons, dated April 25, 1995.

y. GENOT N 8200.58, Change in Offset Localizer, Offset SDF, and LDF Flight Inspection Alignment and Structure Procedures and Tolerances, dated April 28, 1995.

z. GENOT N 8200.59, Change in Order 8200.1, United States Standard Flight Inspection Manual (USSIFM), Paragraph 216.311, dated May 11, 1995.

101.4 EXPLANATION OF CHANGES. This order has been rewritten to eliminate unnecessary information, clarify guidance and procedures, and include new and revised criteria to make them more compatible with new flight inspection equipment and navigational aids. Substantive changes to Sections are as follows:

a. Section 101. Clarifies guidance. Paragraph 101.4b. Changes "presumed" to "understood".

b. Section 104. Clarifies guidance and procedures.

c. Section 105. Removes criteria relative to the Semi-Automatic Flight Inspection (SAFI) program due to cancellation of the program. Adds periodic intervals for DF, VOR/VORTAC/, and TACAN. Adds ILS interval criteria.

d. Section 106. Clarifies guidance and procedures.

e. Section 108. Clarifies guidance and procedures.

f. Section 110. Withdrawn due to cancellation of the SAFI program.

g. Section 201. Clarifies guidance and procedures. Adds alignment orbit procedures. Sections 201 (VOR) and 203 (TACAN/DME) have been combined and renamed Rho-Theta Systems.

(1) Paragraph 201.11. Deleted. Acronyms and abbreviations incorporated into Paragraph 301.2.

(2) Paragraph 201.31. Adds alignment orbit requirements every 900 days.

(3) Paragraph 201.32052. Adds alignment orbit procedures and course improvement adjustments.

(4) Paragraph 201.3209. Clarifies standby transmitter requirements.

(5) Paragraph 201.41 Deleted sentence - not required.

(6) Paragraph 201.44b(3). Added graphical average modulation evaluation.

(7) Paragraph 201.47d. Added reference for bend evaluation.

(8) Paragraph 201.5. First paragraph, corrected typographical error.

h. Section 202. Clarifies guidance and procedures. Paragraph 202.3202, redefined the two means of identification for the VOT.

I. Section 203. Withdrawn. TACAN/DME information included in Section 201.

j. Section 204. Paragraph 204.31--Clarifies guidance and adds a footnote.

k. Section 207. Clarifies guidance and procedures.

l. Section 209. Paragraph 209.11 deleted. Acronyms and abbreviations incorporated into Paragraph 301.2.

m. Section 210. Added. Outlines procedures for the flight inspection of instrument flight procedures which use FMS multisensor non-VOR/DME Area Navigation Equipment (RNAV) for primary navigation guidance.

n. Section 211

(1) Paragraph 211.11. Deleted. Acronyms and abbreviations deleted from Section 211 and incorporated into Paragraph 301.2.

(2) Paragraph 211.31. Changed AWOS/ ASOS reference paragraph.

o. Section 212. Clarifies guidance and procedures.

p. Section 213. Added--Flight inspection of the Global Positioning System (GPS).

q. Section 214. Clarifies guidance and procedures.

r. Section 215. Clarifies guidance and procedures.

s. Section 216. Clarifies guidance and procedures.

t. Section 217. Clarifies guidance and procedures.

u. Section 218. Clarifies guidance and procedures. Paragraph 218.3. First paragraph, third sentence. Remove "no" from the sentence.

v. Section 219. Clarifies guidance and procedures.

w. Section 220. Added--Flight Inspection of the Microwave Landing Systems (MLS).

x. Section 301

(1) Paragraph 301.1. Page 301-7. Adds two definitions. Page 301-12. Deletes SAFI acronym and definition. Page 301-17. Deletes SAFI acronym.

(2) Paragraph 301.2 Page 301-15. Adds or modifies acronyms.

101.5 BACKGROUND

a. U.S. Policy. International Group on International Aviation (IGIA) 777/4.6G specifies that the FAA will provide flight inspection of the common air navigation system, U.S. military aids worldwide, reimbursable services to other countries, and encourage other countries to establish their own flight inspection capability.

b. Program Objectives. The following objectives reflect FAA philosophy. Current and future planning should be aligned to these objectives.

(1) Adequate site survey and analysis of ground and inflight data.

(2) Correlated ground and flight measurements at the time of facility commissionings.

(3) System reliability to meet justified user needs.

(4) Maximum reliance on ground measurements supported by inflight measurements of those facility parameters which cannot satisfactorily be measured by other means.

(5) Through continued inflight surveillance of the National Airspace System (NAS), determine system adequacy, isolate discrepancies, and provide feedback for system improvement.

c. The Interface with Agency Rules. Instrument flight procedures and ATC services require periodic flight surveillance of the air navigation system and dictate strict enforcement of the performance standards adopted for each aid.

d. Flight inspection programs were unified under the FAA by Executive Order 11047, August 28, 1962, subject to the provisions of Executive Order 11161, July 7, 1964. The programs are based on joint DOD/FAA standards, procedures, techniques, and criteria.

e. The design standards for air navigation services are documented in Annex 10 to the Convention on International Civil Aviation Organization (ICAO); AC 00-26, Definitions of U.S. National Aviation Standards; and FAA directives.

f. Quality Assurance. Flight inspection is the quality assurance program which verifies that the performance of air navigation services and associated instrument flight procedures conform to prescribed standards throughout their published service volume.

101.6 DEFINITIONS. This manual contains policy statements and guidance material. Directive verbs are used.

a. Use SHALL when an action is mandatory.

b. Use WILL when it is understood the action will be taken.

c. Use SHOULD when an action is desirable but not mandatory.

d. Use MAY when an action is permissible.

101.7 UNIT OF MEASUREMENT. Unless otherwise stated, the following references are used throughout this manual:

Term(s)	Referenced to
Mile	Nautical Miles
Airspeeds and Ground Speeds	Knots
Bearings, Headings, Azimuths, Radials Direction Information and Instructions	Magnetic North
Altitudes	Absolute (True Height Above the Site or Terrain)

101.8 IDENTIFYING CHANGES IN THE TEXT OF THIS MANUAL. A vertical bar is used to highlight substantive changes in the text. The bar will be inserted in the left margin of each column to identify the changes. This paragraph is used as a typical example.

101.9 AUTHORITY TO CHANGE THIS MANUAL. The Administrator, in coordination with the DOD, reserves the authority to approve changes which establish policy, delegate authority, or assign responsibility. The Program Director of Aviation System Standards may issue changes as necessary to implement policy and standardize procedures and techniques for the flight inspection of air navigation services to ensure accomplishment of the U.S. Flight Inspection Program.

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SECTION 103. SPECIAL REQUIREMENTS

103.1 INTRODUCTION. This section describes the concept for the special requirements of the aircraft, flight inspection crewmembers, and airborne and ground support equipment used for flight Inspection.

103.2 AIRCRAFT. Flight inspection organizations (Office of Aviation System Standards (AVN), regions, and the U.S. Military) shall identify specific requirements based on their operational needs. The general characteristics of an aircraft used to perform flight inspection are as follows:

a. Reliable multi-engine type aircraft capable of safe flight with one engine inoperative and equipped for night and instrument flight.

b. Sufficient capacity for a flight inspection crew, observers, ground maintenance and/or installation personnel, and required electronic equipment with spares.

c. Sufficient range and endurance for a normal mission without reservicing.

d. Aerodynamically stable throughout the speed range.

e. Low noise and vibration level.

f. Adequate and stable electrical system capable of operating required electronic and recording equipment and other aircraft equipment.

g. Wide speed and altitude range to allow the conduct of flight inspections under normal conditions as encountered by the users.

h. Appropriate for modifications of flight inspection of new and improved navigation services.

103.3 FLIGHT INSPECTION CREWMEMBERS. Flight inspection organizations certifying air navigation services shall develop a program to formally certify flight inspection personnel. The objectives of this program are to:

a. Grant authority to the flight inspection crewmember who carries out the administration's responsibility of ensuring the satisfactory operation of air navigation services and/or instrument flight procedures.

b. Provide a uniform method for examining employee competence.

c. Issue credentials which authenticate certi-fication authority for the crewmember.

103.4 AIRBORNE AND GROUND SUPPORT EQUIPMENT. Aircraft and ground support flight inspection equipment shall be calibrated to a standard traceable to the National Bureau of Standards (See TI 4160.1).

SECTION 104. TYPES AND PRIORITIES OF FLIGHT INSPECTIONS

104.1 INTRODUCTION. Official flight inspections are of five basic types: site evaluation, commissioning, periodic, special, and surveillance.

104.2 SITE EVALUATION: A flight inspection to determine the suitability of a proposed site for the permanent installation of a facility. It may include checks normally made during a commissioning inspection and any additional tests which may be required.

104.3 COMMISSIONING: A comprehensive flight inspection designed to obtain complete information as to system performance and to establish that the system will support its operational requirements.

104.4 PERIODIC: A regularly scheduled flight inspection to determine that the system meets standards and supports the operational requirements.

104.5 SPECIAL FLIGHT INSPECTIONS are requested outside of the normal periodic interval. They may be used to define performance characteristics of systems, subsystems, or individual facilities.

104.51 After Accident. This inspection is performed at the request of the accident coordinator/investigator to verify that system performance is satisfactory and continues to support instrument flight procedure(s).

a. Response. This inspection has the highest priority of all flight inspection activities and shall be accomplished as soon as possible.

b. Preflight Requirements. The flight inspector shall obtain the following information:

(1) Equipment configuration at the time of the accident, i.e., the receiver(s), transmitter(s), or radar channel(s) in operation.

(2) Instrument flight procedure(s) used.

(3) Any additional information that may aid in the inspection analysis.

c. Inspection Procedure(s).

(1) Coordinate with maintenance to configure the system as indicated in paragraph b(1).

(2) Complete periodic checklist requirements. Only the equipment and instrument flight procedures used by the accident aircraft need to be checked. Do not make any facility adjustments during the after accident inspection. Any adjustments shall require a separate special inspection.

(3) If a system or procedure has no periodic inspection requirements, evaluate performance in the area in which the accident occurred.

(4) Complete any additional items requested by maintenance, air traffic control personnel, the accident coordinator, or the commander at a military facility.

(5) Where an accident involves contact with the terrain or a manmade obstruction, confirm the procedural controlling obstruction by map study or flight evaluation.

d. Dissemination of After Accident Information. All flight inspection findings or other pertinent accident investigation information shall be restricted to the cognizant accident coordinator/investigator, maintenance, and air traffic personnel. Results of the flight inspection shall be given to the FAA Inspector-in-Charge (IIC) as soon as possible. A flight inspection report shall be filed in accordance with current directives.

104.52 Reconfiguration. A special flight inspection requested by maintenance when modifications or the relocation of a facility could affect signal-in-space parameters. Inspect to the extent necessary to ensure satisfactory performance throughout the service volume; commissioning tolerances shall be applied.

104.53 Inspections of Shipboard TACANs are considered complete at the termination of the inspection. Any subsequent inspection shall be a new "special" inspection.

104.6 SURVEILLANCE. A flight inspection performed on a commissioned system or procedure that determines if the parameter(s) inspected meets standards. An out-of-tolerance condition found on a surveillance inspection shall require a special flight inspection and a flight inspection report.

104.61 Surveillance of Aeronautical Services. During the course of routine flight check operations, flight inspection personnel shall be alert for items which are unusual, substandard, or possibly hazardous.

a. Inspections. Inspections shall include, but not be limited to, the following:

(1) Condition of runways, taxiways, and ramp areas.

(2) Runway, taxiway paint markings, and position signs missing or deteriorated to the extent that visual guidance is obscured or missing.

(3) Construction activity at airports which is a hazardous condition or might affect NAVAID performance.

(4) New obstructions in the instrument approach area which might become the controlling obstruction or constitute a hazardous condition.

(5) Brush or tree growth obstructing the view of approach lights.

(6) Obscured or broken runway or obstruction lights.

(7) Other hazardous situations, e.g., bird hazards.

(8) Air traffic services, e.g., clearances, flight plans, communications, etc.

(9) Other services, e.g., weather bureau services or other airport support services.

b. Reports. See FAA Order 8240.36, Instructions for Flight Inspection Reporting, latest edition.

104.7 PRIORITIES OF FLIGHT INSPECTIONS. The priority for flight inspections shall be:

Priority	Type of Service
1a	Accident Investigation, any facility which has exceeded its inspection interval, inspection of facilities in support of military contingencies, or other nationally directed military deployments.
1b	Restoration of a commissioned facility after an unscheduled outage, restoration of CAT II/III ILS approach minimums, or inspection of NAVAIDs in support of military operational readiness and JCS directed exercises.
1c	Flight inspection of reported malfunctions.
1d	Restoration of a commissioned facility following a scheduled shutdown or inspections supporting DOD NAVAID evaluations (USAF TRACALS).
2a	Site evaluation.
2b	Commissioning inspection of a new facility or new instrument flight procedures.
3a	Periodic inspections.
3b	Restoration of standby equipment (except CAT II/III ILS, see priority lb).
3c	Restoration of VFR training facilities following a scheduled or unscheduled outage.

SECTION 105. FREQUENCY OF PERIODIC FLIGHT INSPECTIONS

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SECTION 105. FREQUENCY OF PERIODIC FLIGHT INSPECTIONS

105.1 INTRODUCTION. This section prescribes the minimum frequency of periodic flight inspections. More frequent inspections may be made when deemed necessary or as requested by the owner or organization responsible for the operation of the facility.

105.11 General

a. Intervals. Table 105-1 specifies the intervals between scheduled periodic flight inspections. Due dates for periodic inspections are based on this schedule. Military, foreign, and MOA systems, facilities, and procedures may have unique requirements and non-standard inspection intervals.

(1) Due date window for facilities with a SPAR 1 is from 15 days before to 15 days after due date.

(2) Due date window for facilities with a SPAR 2 or SPAR 3 is from 30 days before to 30 days after the due date.

(3) Due date window for all other facilities, systems, and procedures is from 45 days before to 45 days after the due date.

b. Priority. The inspection priority shall be raised to 1a when the system, facility, or procedure is within seven (7) calendar days of the end of the due date window.

c. Scheduling. Periodic inspections are considered complete when all scheduled checks are accomplished.

105.12 Inspection Dates. All records and reports will reflect the actual date(s) of the inspection and will specifically denote the date of completion. For inspections completed within the due date window or extension, the next inspection will be predicated upon the scheduled facility due date.

a. Progressive Inspections. The requirements for periodic inspections are specified in a checklist in each section of this order. Partial or progressive inspections may be conducted, provided all of the individual periodic checklist items are satisfied within the due date window.

b. NAVAID System Scheduling. NAVAIDs such as VORTAC, VOR/DME, ILS, MLS, etc., shall be flight inspected as a service with the same due date and inspection interval for all component facilities.

c. Standard Instrument Approach Procedure (SIAP). SIAP evaluations shall be coincident with inspections of the supporting navigation service as detailed in Table 105-1.

105.2 Extension of Services Overdue Periodic Inspection. When the inspection of a commissioned facility is not completed within the due date window, the facility may continue to operate for seven (7) additional calendar days. This extension shall only be implemented if the following action is taken:

a. Flight inspection and regional facility maintenance engineering shall agree that no conditions exist that could adversely affect the safety of flight if the facility is left in service. The facility operations history shall be carefully considered.

b. The justification for granting an extension shall be documented and retained in the flight inspection facility file for a period of one year.

105.3 NAVAIDS Temporarily Out-of-Service.

a. Use the priority listed in paragraph 104.7 of this order when a restoration inspection is required. The next periodic inspection shall be predicated on the completion date of an inspection which satisfies all periodic checklist requirements.

b. When a portion of a NAVAID is restored to service, the periodic due dates shall be established in accordance with paragraphs 105.11 and 105.41.

c. Standby Equipment. When flight inspection of standby equipment is required but cannot be accomplished, the periodic inspection shall be considered complete if the standby equipment is:

(1) Out-of-service (awaiting parts, etc.) or;

(2) Removed from service (due to an uncorrectable discrepancy, etc.) The standby equipment shall be restored to service by the successful completion of a flight inspection which satisfies all periodic requirements (including monitors, where applicable).

105.4 Periodic Flight Inspection Intervals. The schedule for periodic flight inspections shall be in accordance with Table 105-1.

105.41 System Performance Analysis Rating (SPAR). Periodic flight inspection requirements for PAR, ILS, SDF, LDA, and MLS services are based on system performance. The interval is determined as follows:

a. Establishing the Interval.

(1) Newly commissioned facilities shall initially be inspected at the 90-day interval (SPAR 1) interval, and then progress as outlined in paragraph 105.41b.

(2) Facilities Reconfigured in accordance with paragraph 104.52 shall be inspected at the 90-day interval (SPAR 1). If the facility performs satisfactorily during the SPAR 1 inspection, flight inspection and facilities maintenance engineering may agree to restore the original SPAR rating.

b. Changes to the periodic interval are determined by the performance of the service or facility. The recommended changes to the SPAR interval are:

(1) The interval will be decreased by one SPAR Class if a monitored parameter is found out-of-tolerance for two consecutive inspections, either scheduled or special.

(2) The interval will be increased by one SPAR Class if no monitored parameter is found out-of-tolerance during any periodic or special inspection.

105.42 Monitor (or Reference) Interval. The first periodic inspection after a commissioning, reconfiguration, or SPAR interval change shall include a monitor (reference) check, if applicable to the facility. Monitor (or reference) check intervals shall be twice the established facility periodic interval.

Table 105-1 Basic Schedule for Periodic Flight Inspection
(all intervals are in days)

Facility	Interval	SIAP	Facility	Interval	SIAP
PAR, ILS, MLS, SDF, LDA			NDB (UHF, LF/MF)	450	450
SPAR 1	90	540	DF	450	450
SPAR 2	180	540	LORAN C	450	450
SPAR 3	270	540	ASR (Military Approaches)	450	450
VOT	450		GPS		450
VOR, VORTAC, TAC (1)	450	450	FMS		450
DME	(2)	(2)			
VGSI, Marker Beacons, Communications, and Approach Lighting Systems			Inspect these facilities at the same interval as the system or procedure they support		

Notes: (1) 450 days for facilities which support a SIAP or receiver checkpoint. An alignment orbit is required every 900 days for all facilities.

(2) DME facilities shall be inspected at the same interval as the service they support.

c. Standby Equipment. When flight inspection of standby equipment is required but cannot be accomplished, the periodic inspection shall be considered complete if the standby equipment is:

(1) Out-of-service (awaiting parts, etc.) or;

(2) Removed from service (due to an uncorrectable discrepancy, etc.) The standby equipment shall be restored to service by the successful completion of a flight inspection which satisfies all periodic requirements (including monitors, where applicable).

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VOT	450		GPS		450
VOR, VORTAC, TAC (1)	450	450	FMS		450
DME	(2)	(2)			

VGSI, Marker Beacons, Communications, and Approach Lighting Systems	Inspect these facilities at the same interval as the system or procedure they support

Notes: (1) 450 days for facilities which support a SIAP or receiver checkpoint. An alignment orbit is required every 900 days for all facilities.
(2) DME facilities shall be inspected at the same interval as the service they support.

SECTION 106. GENERAL FLIGHT INSPECTION PROCEDURES

106.1 INTRODUCTION. Sequence of events encountered by the flight inspector in the performance of the flight inspection mission is generally as follows:

a. **Request for flight inspection**

b. **Preflight preparation**

c. **Actual flight inspection**

d. **Analysis and evaluation**

e. **Post flight review and reporting**

106.2 REQUEST FOR FLIGHT INSPECTION. Site, commissioning, and some special flight inspections shall be requested by authorized personnel. Requests are not required for periodic flight inspections.

106.21 Status of Equipment. A request for flight inspection should not be initiated until all required facility equipment is installed, properly adjusted, calibrated, and operating normally.

106.22 Notification. The flight inspector or central scheduling and dispatch facility shall notify the appropriate airway facility maintenance personnel of the estimated time of arrival (ETA) of the flight inspection aircraft. As much advance notification as possible shall be provided for a site evaluation, commissioning inspection, periodic with monitors, or special inspections requiring maintenance.

A periodic inspection without monitors does not require pre-coordination with maintenance personnel. This inspection should be conducted on the transmitter in operation. If an out-of-tolerance condition is found, notify maintenance of the discrepancy(ies) found and inspect the standby equipment. NOTAMs should be issued if discrepancies are not corrected.

106.3 PREFLIGHT INSPECTION PREPARATION. A thorough and complete understanding between facilities maintenance personnel and the flight inspection crew is essential for a successful flight inspection. The flight inspector and the person-in-charge of the facility are jointly responsible for the required coordination before, during, and after the flight inspection. The flight inspector will brief the facilities maintenance personnel of intended actions prior to commissioning flight inspections and for special circumstances.

106.31 Facilities Maintenance Personnel. Efficient and expeditious flight inspections require preflight preparations and actions of facilities maintenance personnel. These preparations include the following actions:

a. **Provide adequate two-way radio communications equipment** and power source at facility sites. Two-way communication should be provided by flight inspection when a theodolite or RTT is required.

b. **Ensure that all facility equipment** is calibrated in accordance with technical orders.

c. **Ensure personnel** will be available to make corrections and adjustments.

d. **Provide transportation** to move flight inspection equipment and personnel.

e. **Provide accurate facility data** for new or relocated facilities.

106.32 Flight Personnel. The following actions shall be accomplished prior to the flight inspection:

a. **Ensure that all flight inspection equipment** is calibrated and operational.

b. **Brief facilities maintenance personnel.**

c. **Conduct crew briefing.**

d. **Obtain maps,** charts, equipment, data sheets, etc.

e. **Review the status,** limitations, and characteristics of the facility. Ensure that all publications and records agree with the results of the latest flight inspection, and all applicable restrictions are accurate.

f. Brief the air traffic control (ATC) personnel about the areas and altitudes to be flown during the flight inspection maneuvers and of possible transmitter changes.

106.4 FLIGHT INSPECTION. Perform the flight inspection in accordance with the procedures in Chapter 200 of this manual.

106.41 Operator Proficiency. During flight inspections, qualified personnel will be assigned so operator deviations will not be confused with equipment performance.

106.42 Standby Equipment. It is necessary to know which system or transmitter is operating so the performance of each can be determined.

a. When one unit of a dual equipped facility is found out-of-tolerance, it shall be identified and removed from service. The unit can be identified as transmitter number 1 or 2, channel A or B, serial number, etc.

b. Some inspections may only require the checking of one equipment. The details for each type of facility are included in the appropriate facility checklists.

106.43 Standby Power

a. The flight inspector shall check the facility on standby power during a commissioning flight inspection if standby power is installed. If a standby power system is installed after the commissioning flight inspection, the flight inspector shall check the facility on standby power during the next regularly scheduled periodic inspection. The flight inspector shall make comparative measurements to ensure that facility performance is not derogated on the standby power system and that all tolerance parameters for the specific inspection are met. Standby power checks are not required on facilities powered by batteries that are constantly charged by another power source.

b. It is not necessary to recheck a facility when the standby power source is changed.

106.44 On-Station Philosophy. Flight inspectors shall assist in the correction of all facility deficiencies prior to departure. Every effort should be made to restore the facility to service.

106.45 Adjustments. Requests for adjustment shall be specific. The flight inspection crew will furnish sufficient information to enable maintenance personnel to make adjustments. Adjustments which affect facility performance shall be rechecked by flight inspection.

Flight inspection certification shall be based on facility performance after all adjustments are completed.

106.5 ANALYSIS AND EVALUATION

a. Flight inspection data shall be analyzed and evaluated by flight inspection using the tolerances specified in this manual. Recordings made during the flight inspections are the permanent records of facility performance.

b. On request, pertinent flight recordings will be made available to facilities maintenance personnel for engineering analysis. The recordings will be preserved and promptly returned to the flight inspection unit upon completion of the analysis.

106.6 POST FLIGHT INSPECTION ACTIONS. Upon completion of the flight inspection, the flight inspection crew shall perform the following actions:

a. Brief facilities maintenance personnel

b. Determine facility status

c. Prescribe the issuance and/or cancellation of NOTAMs.

d. Prepare flight inspection reports

e. Ensure flight information is published

106.61 Brief facilities maintenance personnel concerning results of the flight inspection. Flight inspection shall report all facility outages to appropriate personnel.

106.62 Facility Status. Flight inspection shall assign a status for the facility (see Section 107). Flight Inspection shall also notify the appropriate personnel of the facility status.

106.63 NOTAMs. The flight inspector shall prescribe the issuance and/or cancellation of NOTAMs based on the flight inspection (see Section 107.)

106.64 Reports. Flight inspection reports shall be accurate and describe facility performance and characteristics. Reports shall be completed in accordance with FAA Order 8240.36, Instructions for Flight Inspection Reporting, latest revision.

106.65 Flight Information. The flight inspector shall provide information for publication.

a. Receiver Checkpoints. The following information shall be provided for receiver checkpoints:

(1) Airport name

(2) Bearing in degrees magnetic from the VOR/TACAN

(3) Location and description

(4) Distance and altitude

NOTE: Examples--

1. Ground Checkpoint. Central City, Utah, (Municipal): 130°, 4.5NM, runup pad Rwy 14.

2. Airborne Checkpoint. Mudville, Ohio, (Jones): 148°, 5.7NM, over int Rwys 20 and 13; 3,300 feet.

b. VOR Test Facilities (VOT). The following information shall be provided for a VOT:

(1) Facility name (and airport name)

(2) VOT frequency

(3) Type facility (area or airport)

(4) Information describing usable area

SECTION 107. FACILITY STATUS CLASSIFICATION AND NOTICES TO AIRMEN (NOTAM)

107.1 INTRODUCTION. Air navigational and traffic control facilities are expected to be usable within specific limits of distances and altitudes (service volume). Facility status classification and NOTAMs will indicate restriction(s) to the expected use of these facilities. The facility status classification indicates the general performance of the facility as determined from each flight inspection. This classification is directed only to the maintenance and/or operating agency. The NOTAM advises the user of any restriction to facility usage.

107.2 FACILITY STATUS CLASSIFICATION. Based on the performance of the facility, flight inspection shall assign one of the following status classifications:

a. Unrestricted. The status of a facility which meets established tolerances.

b. Restricted. The status of a facility which does not meet established tolerances (areas shall be clearly defined as unusable in a NOTAM).

c. Unusable. The status of a facility which is unsafe or unreliable for navigation (a NOTAM shall be issued for the facility defining it as unusable).

107.3 NOTAMs.

a. Facility NOTAMs. The flight inspector shall immediately initiate NOTAM action whenever a facility restriction is found or revised. FAA Order 7930.2, Notices to Airmen (NOTAM) Handbook (latest edition), and the instructions in this order shall be used to issue NOTAMs. An FDC FI NOTAM shall be issued if a restriction affects instrument flight procedures, approach minimums, or category (CAT) II or III authorizations. To initiate NOTAM action, advise the appropriate Flight Service Station (FSS) or Military Base Operations (for Army facilities, notify the ATC Facility Chief). Recommend a NOTAM be issued defining the restrictions found. The flight inspector shall verify that the appropriate NOTAMs were issued correctly within 24 hours.

The flight inspector shall verify that the correct NOTAM is published in the appropriate agency publications.

b. Instrument Flight Procedures. The flight inspector shall coordinate NAVAID NOTAMs with the procedures specialist, as restrictions to NAVAIDs may affect published instrument flight procedures. The procedures specialist shall:

(1) Determine what published instrument flight procedures are affected.

(2) Initiate appropriate NOTAMs that amend or suspend those procedures by calling the National Flight Data Center (NFDC), Flight Procedures/Airspace Section, ATM-613, for civil and Army facilities, (for other military facilities, notify the appropriate Military Base Operations).

NOTE: During NFDC non-duty hours (1700-0800 eastern), the FDC NOTAM is to be forwarded to the NOTAM office (ATM-611).

(3) Review the NAVAID restrictions to determine what effect they will have on the instrument flight procedures. The central scheduling and dispatch facility will ensure that the required NOTAMs are immediately transmitted to NFDC. If the procedures specialist is not available, the flight inspector shall verify that any required NOTAMs are issued.

c. Facilities not requiring NOTAMs. Do not issue a NOTAM to reflect restrictions found during the flight check of radar or direction finding facilities; however, review the instrument flight procedures to ensure that those requiring ground radar are amended or suspended. Coordinate this action with the procedures specialists.

d. Expanded Service Volume (ESV) Facilities. When a facility no longer supports an ESV, the facility is not restricted, but a NOTAM must be issued for the instrument flight procedures predicated on that ESV. Coordinate and publish the newly established ESV and instrument flight procedures.

e. Out-of-Tolerance Standby Equipment. Where one of two transmitters of a facility is restricted due to out-of-tolerance parameters and the other is satisfactory, the satisfactory transmitter may be operated without a NOTAM. However, NOTAM data describing the restriction shall be provided to facilities maintenance personnel. In the event the restricted transmitter is used, the operating agency shall issue the NOTAM.

107.31 NOTAMs on Military Facilities (including ships).

a. The military installation commander has the final authority and responsibility for NOTAM issuance and for facility operations of all military facilities which are not part of the National Airspace System (NAS). The commander may elect to use "For Military Use Only" facilities found unsatisfactory for continued NAS usage.

b. The flight inspector will recommend NOTAMs to the military commander's representative (see paragraph 107.34) when facilities under the commander's jurisdiction require NOTAM action.

c. NOTAMs shall not be issued on shipboard facilities.

107.32 Preparation of NOTAMs

a. NOTAMs shall include facility name, type, component, and the unusable area/altitude. The absence of a specific altitude or distance will denote all altitudes and distances. It is important to include specific information to avoid confusion. The reason for the restriction, e.g., lack of signal, frequency interference, course structure, alignment, unlocks, etc., serves no useful purpose and shall not be included in the text of the NOTAM.

b. Restrictions to TACAN azimuth are not included in agency publications, but are referred to the military for dissemination as they consider necessary. A copy of each NOTAM issued or recommended for TACAN azimuth restrictions shall be retained in the facility file for reference during subsequent flight inspections. The NOTAM preparation for the TACAN azimuth component of a VORTAC is identical to the VOR.

107.33 Facility Restrictions. Apply the following rules for restricted facility use:

a. Describe the radials or bearings that are unusable.

b. Describe the altitude and mileages that are unusable.

107.34 NOTAM Examples. The following are examples of conditions and prescribed NOTAMs:

a. Condition 1. All components of a VORTAC are unusable in a specific sector due to out-of-tolerance VOR and TACAN course structure and unusable DME. **NOTAM**, Chicago VORTAC: VOR, DME, and TACAN azimuth unusable, 025-075° beyond 25 NM below 3,500 feet.

b. Condition 2. A VOR does not provide adequate signal to 40 miles at the required altitudes in various areas. **NOTAM** Altoona VOR: VOR unusable, 080-100° beyond 18 NM below 3,500 feet; 101-200° beyond 30 NM below 3,500 feet; 201-300° beyond 30 NM below 4,500 feet; 301-350° beyond 15 NM; 351-010° beyond 30 NM below 4,000 feet.

c. Condition 3. VOR is unusable in various areas below one altitude. Also, the DME is unusable in one sector. **NOTAM,** Yardley VORTAC: VOR unusable below 1,700 feet in the following areas: 250-265° beyond 17 NM; 266-280° beyond 10 NM; and 281-290° beyond 17 NM. DME unusable 225-275° in the following areas: Beyond 15 NM below 2,400 feet and beyond 30 NM below 5,000 feet.

d. Condition 4. A Nondirectional radio beacon is not usable in the Southeast quadrant. **NOTAM** Bradford NDB: unusable 090-180° beyond 15 NM.

e. Condition 5. Glide slope tolerances are exceeded at a specific point on the glidepath. **NOTAM**, Ashville Regional, NC: Rwy 16 ILS glide slope unusable below 2,310 feet MSL.

f. Condition 6. An ILS localizer exceeds tolerances at 1/2 mile from the runway threshold. **NOTAM,** Hartsville Muni, SC, Rwy 16 ILS unusable from 1/2 NM inbound.

g. Condition 7. Cat II ILS ceases to meet CAT II criteria. FDC, FI/(P or T), **NOTAM** William B. Hartsfield, Atlanta Int'l, GA: ILS Rwy 9R, CAT II NA.

NOTE: FI/P means permanent and FI/T means temporary flight information.

h. Condition 8. CAT III ILS localizer exceeds CAT III tolerances in zone 4. **FDC, FI/P NOTAM** Charleston AFB/Int'l SC: Rwy 15 ILS, CAT III NA.

i. Condition 9. CAT II ILS localizer exceeds tolerances in zone 4. **NOTAM,** New Orleans Int'l, LA: Rwy 28 ILS LOC unusable inside runway threshold.

NOTE: The localizer is unrestricted.

j. Condition 10. CAT III ILS localizer exceeds tolerances in zone 5. **NOTAM,** New Orleans Int'l, LA: Rwy 28 ILS LOC unusable for rollout guidance.

k. Condition 11. Glide slope does not meet change/reversal tolerances below a point on the glidepath. **NOTAM,** Ashville Regional, NC: Rwy 16, ILS glide slope unusable for coupled approaches below 2,000 feet MSL.

l. Condition 12. Localizer does not meet tolerances in the vertical plane. **NOTAM,** Wellsville Municipal Arpt., Tarantine Field Arpt., Wellsville, NY: ELZ LOC Rwy 28, LOC unusable beyond OM above 3,500, at threshold above 500.

m. Condition 13. Beyond 5° left of LOC course, there are no glide slope clearances above path, and a glidepath is not provided. **NOTAM,** Charlotte/Douglas Int'l, NC: Rwy 36R ILS glide slope unusable beyond 5° left of LOC course.

n. Condition 14.

(1) MLS Azimuth Unusable. Because an unusable approach azimuth renders the elevation unusable, refer to any unusable azimuth segment as "MLS unusable". Describe the limits using **inbound courses;** e.g.:

(a) UMP MLS unusable 196 to 206 degrees.

(b) UMP MLS unusable 196 to 206 degrees below 4 degrees.

(c) UMP MLS unusable 196 to 206 degrees beyond 15 DME below 4,000 feet MSL.

(2) Elevation. Refer to any unusable segment as "MLS elevation unusable"; e.g.,

(a) UMP MLS elevation unusable 151 to 156 degrees below 3.5 degrees

(b) UMP MLS elevation unusable 151 to 156 degrees beyond 15 DME below 7,000 feet MSL.

(3) MLS DME unusable. Refer to any area of unusable DME as "UMP MLS DME unusable".

107.35 Required Advisories for Local NOTAMs. The flight inspector shall notify Air Traffic (AT) personnel when the facility is not authorized for use because of flight inspection actions.

SECTION 108. RECORDS AND REPORTS

108.1 Introduction. This section provides policy for flight inspection reports and records. All digital analog and pictorial data provide the basis for real-time certification of the quality of signal in space. The flight inspection report provides permanent, historical interpretation of a system's performance. The report shall accurately reflect the operational status of the system, the quality of the signal in space, and the instrument flight procedure it supports.

108.2 Records. Flight inspection files are Federal record material. The standards for their retention and destruction are contained in FAA Order 1350.15, Records Organization, Transfer, and Destruction Standards. Flight reports of flight inspection aids to air navigation, as well as recorder charts, inspection worksheets, polar plots of coverage patterns, error curve graphs, and related correspondence, constitute report files. Other material may include data items which are necessary for flight inspection purposes, such as horizon profiles, site drawings, topographic charts, instrument approach/departure procedure charts, photographs and data sheets, aircraft logbooks, etc.

a. General Information. Ensure that any information that is included in the facility file is annotated with the following information:

(1) Facility identification/type of facility
(2) Date(s) of inspection
(3) Type of inspection, e.g., periodic, etc.
(4) Aircraft tail number
(5) Crew initials and numbers
(6) Recorder calibration
(7) Equipment-required flight inspection self-test

108.21 Facility Data Sheets. The flight inspector shall ensure that the facility data reflects the most current information and is sufficient to complete the flight check requirements.

108.3 Reports. The flight inspection report serves as the primary means of documentation and dissemination of the results of each flight inspection. Requirements for the use, completion, and distribution of standard FAA and suitable military flight inspection forms are contained in FAA Order 8240.36, Instructions for Flight Inspection Reporting (latest revision).

108.31 Military Facilities

a. Changing a Facility Classification to Restricted or Unusable or Altering a Restriction. When the results of the flight inspection indicate that the facility classification is to be changed to "restricted" or "unusable" or that facility restrictions have changed, land the aircraft, if practical, and discuss the reasons and recommended action with appropriate representatives of the base commander. If it is impractical to land, give a status report to the control tower (on ground or tower frequency) indicating the exact status of the facility (unrestricted, restricted, or unusable) and all discrepancies found. Provide them with suggested wording for any required NOTAM's (see Section 107). Request acknowledgement of the information.

b. Where there has been no change in facility performance, inform the control tower (on ground or tower frequency) of the exact facility classification. Again, request acknowledgement.

c. If a military installation does not have a control tower, attempt to pass the information over any other available air-to-ground frequency that would ensure dissemination of the flight check results. If no appropriate air-to-ground frequency is available and it is impractical to land, telephone the appropriate personnel as soon as possible.

d. In any of the above cases, inform the appropriate military maintenance personnel of any discrepancies discovered, and the resulting facility classification.

108.32 Reports Submitted by Military Flight Inspectors.

a. Flight inspection reports of facilities inspected by military flight inspection crews, who have been delegated the authority for execution of the flight inspection mission, shall be accepted by the FAA as official flight inspection reports.

b. Military flight inspectors shall assign a classification or status to those facilities for which they have flight inspection responsibility.

NOTE: Coordination may be in the form of a letter of agreement or may be handled on a case-by-case basis. Coordination with AVN constitutes full flight inspection authority for the respective facility.

SECTION 109. MILITARY EMERGENCY AND NATURAL DISASTER FLIGHT INSPECTION PROCEDURES

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SECTION 109. MILITARY EMERGENCY AND NATURAL DISASTER FLIGHT INSPECTION PROCEDURES

109.1 Introduction. The potentially catastrophic consequences of a major natural disaster or the need to respond quickly to a military emergency necessitate advanced planning and definition of operational requirements. In such circumstances, military flight inspection resources will become critical in the restoration of navigational aids. The ability to provide sustained flight inspection support for the numerous and diverse requirements which may exist will be predicated upon the use of abbreviated flight inspection procedures. Flight inspection will greatly depend on both air traffic and facility maintenance support preparations.

109.11 Purpose. The guidance, procedures, and tolerances contained in this section describe the minimum facility performance standards when emergency situations require deviation from normal standards. Basic flight inspection requirements and methods of taking measurements apply to the emergency section unless specific guidance or tolerances are given. Facilities which have been placed in operation using these procedures shall be re-inspected to normal standards when circumstances permit.

109.12 Authority

a. The authority to implement these provisions may be exercised by either military or FAA. When military authority determines that an operational situation dictates the application of these procedures and tolerances, the appropriate flight inspection activity and the FAA Aviation System Standards Office (AVN) Manager, Flight Inspection Operations Division, AVN-200, shall be notified. Application to civil facilities will be determined by appropriate FAA authority, who shall notify both AVN-200 and appropriate military authority. The Flight Inspection Operations Division, AVN-200, is responsible for issuing a General Notice (GENOT) and initiating a Notice to Airmen (NOTAM) regarding implementation of abbreviated procedures to provide facilities for emergency use.

b. Flight inspection personnel, performing facility inspection and certification using the provisions of this section, must be authorized and qualified to perform flight inspection duties.

109.2 Preflight Requirements.

109.21 Aircraft and Equipment.

a. If necessary, equipment which has exceeded calibration due dates may be used for emergency flight inspection. Calibrated equipment shall be used when the facility is subsequently inspected using standard procedures.

b. The use of other than a flight inspection-configured aircraft may be necessary. Reliability of such equipment shall be established before use by the flight inspector. Examples of test methods available to verify the accuracy of uncalibrated flight inspection systems or aircraft not equipped with a flight inspection system are:

(1) Comparison with a facility verified by maintenance, or another flight inspection aircraft, as operating normally.

(2) Comparison with two or more facilities in operation.

(3) Use of a VOT or similar radiated test signal.

109.22 Types and Priorities of Emergency Flight Inspection.

a. Only special and commissioning type flight inspections (reference Section 104) will be conducted under emergency conditions using the procedures contained in this section. After-accident flight inspections may also be conducted under emergency conditions, but normal procedures shall be followed.

b. Priorities shall be established at field level if mutual agreement can be reached. Conflicts will be resolved by AVN-200.

109.23 Preinspection Requirements

a. Prior to arriving on location, the flight inspector or central scheduling and dispatch facility shall contact the air traffic control manager and the facility maintenance supervisor in order to coordinate the following items:

(1) Arrival time

(2) Emergency operational requirements as defined by the air traffic control manager.

(3) Airspace requirements for conducting the flight inspection profile.

(4) Anticipated support such as refueling, ground transportation for a theodolite operator, etc.

b. The air traffic control manager shall accomplish the following prior to arrival of the flight inspection aircraft.

(1) Make final determination regarding emergency operational requirements for the facilities and SIAP's requiring flight inspection, and be prepared to brief changes on initial contact.

(2) Coordinate airspace requirements and obtain necessary clearances from appropriate airspace control authorities for conducting the inspection.

(3) If required, designate and brief an air traffic controller to work the flight inspection aircraft.

(4) Provide current facility data (FAA Form 8240-22) for each facility to be inspected.

c. The facility maintenance supervisor shall:

(1) Ensure adequate radio communications are available and operational.

(2) Assigned qualified maintenance personnel to support the flight inspection of the equipment being inspected.

(3) Assist the Air Traffic Control Manager in completing FAA Form 8240-22 (Facility Data Sheet) for each facility to be inspected.

(4) Arrange for ground transportation for the theodolite operator if necessary.

109.3 Approach Procedures

a. The minimum flight inspection required to certify published SIAP's is the inspection of the final approach and missed approach segments.

b. If an approach must be established, the flight inspector may be responsible for establishing final and missed approach procedures. Both segments of the procedure shall be flown and recorded to establish and document flyability, accuracy, reliability, and obstacle clearance. The flight inspector shall record the emergency SIAP procedures on the flight inspection report and provide the air traffic control watch supervisor with adequate detail for issuance of the NOTAM.

c. In all cases, the flight inspector shall determine, through visual evaluation, that the final and missed approach segments provide adequate terrain and obstacle clearance.

109.4 En route and Transition Coverage. If there is a need for facility coverage to provide en route and transition to terminal environment guidance, air traffic control shall use aircraft of opportunity to fly the transition procedure. Pilot reports of satisfactory cockpit instrument performance and controller evaluation of radar target strengths are sufficient for air traffic control to determine usability.

109.5 Facility Status and NOTAM's

a. Prior to beginning the inspection, the flight inspector shall ascertain from air traffic control the intended operational use of the facility. After completing the inspection, the inspector shall determine the facility status for emergency use and advise the air traffic control watch supervisor prior to departing the area.

b. Upon being advised of the status, the air traffic control watch supervisor shall ensure issuance of a NOTAM. Unusable SIAP's, or portions thereof, shall be included in the NOTAM (e.g., ELP VOR and TACAN: VOR SIAP runway 26L unusable TACAN SIAP runway 26L unusable). The NOTAM for a civil facility must be issued as a NOTAM D to ensure that information is made available using the most expeditious method. Therefore, NOTAM's which are lengthy and describe emergency-use NAVAID's in great detail will not be issued. The flight inspector shall subsequently record the NOTAM text in the remarks section of the applicable flight inspection report.

c. The flight inspector has the authority and responsibility for determining that a NAVAID can safely and adequately support the operations intended under emergency conditions. However, military installation commanders have final authority and responsibility for operation of military facilities which are not part of the common system, and may elect to use those facilities FOR MILITARY MISSIONS. Additionally, the military may elect to use a military or civil NAVAID, which is part of the common system, even though that NAVAID is considered unusable by the flight inspector. In all such cases, the military installation commander is responsible for issuance of an appropriate NOTAM advising that the NAVAID is in operation "For Military Emergency Use Only" to support emergency operations.

109.6 Flight Inspection Documentation and Reports

a. Flight inspection recordings shall be retained until the facility can be inspected using normal procedures and tolerances. In the event that flight inspection equipment is inoperative or not available, flight inspections will continue to meet emergency operational requirements until replacement or repair is practical. Under these circumstances, the flight inspection pilot and airborne electronic technician are jointly responsible for documenting all of the applicable data displayed by instrumentation at their crew duty positions. All such manually-acquired data shall be identified in the remarks section of the flight inspection report. The facility/SIAP shall be reflown with operational flight inspection equipment when conditions permit.

b. Completion and distribution of flight inspection reports are secondary to the accomplishment of emergency flight inspection. At the conclusion of the inspection, the flight inspector shall pass the facility status to the air traffic control watch supervisor on an air traffic frequency. This will suffice as the official report until the written report has been completed and distributed.

c. The flight inspector shall ensure that flight inspection reports are completed and submitted for processing. Each parameter specified in the emergency flight inspection procedures checklists contained herein shall be reported. Flight inspection reports may be handwritten using reproducible ink.

d. Recordings and reports shall reflect that the inspection was accomplished using MILITARY EMERGENCY AND NATURAL DISASTER FLIGHT INSPECTION PROCEDURES.

109.7 Flight Inspection Procedures/Tolerances.

109.71 ILS Glide Slope.

Checks Required	Tolerances/Procedures
Modulation	The modulation and carrier energy level is such that the flag is hidden in the area identified as usable.
Angle	$\pm$ 0.5^0 of desired or commissioned angle.
Coverage	Minimum 15 microvolts signal, 2 NM outside OM of FAF and 150 microvolts
Clearance	Minimum 150*u*A (full scale) fly up and clear all obstructions prior to 1000' from threshold
Course Structure	45*u*A from graphical average for all zones if restricted to manual approaches. Standard tolerances apply if used for coupled approaches.
Flyability	Any condition that may induce confusion will render the facility unusable.
PAR Coincidence	0.2^0. If PAR/ILS coincidence cannot be established, a NOTAM shall be issued.

NOTE: These tolerances and procedures are valid for Category I minimums only. If operational requirements dictate the restoration/commissioning to Categories II or III standards, thflight inspector shall use normal procedures (see Section 217).

109.72 ILS--LOCALIZER

Checks Required	Tolerances/Procedures
Identification	Sufficient information to identify the facility. ID shall not render the facility unusable.
Modulation	The modulation and carrier energy level is such that the flag is hidden at all times in the area identified as usable.
Coverage	15 NM minimum coverage area with 5*u*V minimum signal, not less than 10^0 each side of on-course position.
Course Structure	$\pm$45*u*A from graphical average for all zones if restricted to manual approaches. Standard tolerances apply if used for coupled approaches.
Alignment	30*u*A from designated procedural azimuth.
Clearance	150*u*A minimum throughout established coverage area
Obstructions	Evaluate obstruction effect on procedure
Flyability	Any condition that may induce confusion will render the facility unusable.
Polarization	$\pm$30*u*A

NOTE: These tolerances and procedures are valid for Category I minimums only. If operational requirements dictate the restoration/commissioning to Categories II and III standards, the flight inspector shall use normal procedures (see Section 217).

109.73 Markers/Beacons

Checks Required	Tolerances/Procedures
Identification/	Correct/sufficient to illuminate the proper bulb modulation
Coverage	
Major Axis	Not less than $\pm$ 1/3 HSI deflection
Minor Axis	
Outer marker	3000' $\pm$2000'
Middle marker	No limit
Inner marker	No limit
Fan marker	3000' $\pm$2000' if used for obstacle clearance; otherwise, no limit

NOTES: These tolerances and procedures are valid for Category I minimums only.

If an operational marker or beacon is not available for establishing aircraft position in relation to runway threshold, other methods of position identification (DME fix, radar fix or crossing radial) may be substituted.

109.74 VOR/TVOR

Checks Required	Tolerances/Procedures
Identification	Sufficient information to identify the facility. ID shall not render any parameter unusable.
Sensing and Rotation	Correct
Polarization	$\pm 4.0^{\circ}$
Modulation	25% to 35%
Approach	Alignment within $\pm$ 2.5°. Structure not to exceed $\pm 6.0^{\circ}$. Inspect from FAF to MAP.
Missed Approach	Meets flyability constraints until cnbh7ear of obstructions and course is established.
En Route	Alignment within $\pm 4.0^{\circ}$. Structure not to exceed $\pm$ 6.0°.
Monitors	To be set and checked by maintenance. Flight inspection will verify when practical.
Standby Equipment	Will be checked by transmitter change on approach and en route radials.
Coverage	Sufficient to support requirements.
Flyability	Any condition that may induce confusion will render the procedure or facility unusable.
Voice	Voice shall not render any parameter unusable.

Crosspointer, FLAG, and AGC shall be checked during all flights to and from the facility or starting point of the inspection.

Alignment orbit, coverage orbit, transmitter differential, and inspection of radials 5° each side of final approach radial are not required.

Final approach segments may be inspected inbound or outbound.

109.75 TACAN

Checks Required	Tolerances/Procedures
Identification	Sufficient information to identify the facility. ID shall not render any parameter unusable.
Sensing and Rotation	Correct
Polarization	$\pm$ 4.0°
Distance Accuracy	3% of charted value or 1.0 NM, whichever is greater
Approach	Alignment within $\pm$ 2.5°. Structure not to exceed $\pm 6.0^{\circ}$. 1/4 NM aggregate azimuth, DME unlock, or out-of-tolerance structure permitted. Inspect from FAF to MAP.
Missed Approach	Meets flyability constraints until clear of obstructions and course is established.
En Route	Alignment within $\pm 4.0^{\circ}$. Structure not to exceed $\pm 6.0^{\circ}$. 1.0 NM aggregate azimuth, DME unlock, or out-of-tolerance structure permitted in any 5NM of radial flight.
Monitors	To be set and checked by maintenance. Flight inspection will verify when practical.
Standby Equipment	Will be checked by transponder change on approach and en route radials
Coverage	Sufficient to support requirements.
Flyability	Any condition that may induce confusion will render that procedure or facility unusable.

Crosspointer, FLAG, and AGC shall be checked during all flights to and from the facility or starting point of the inspection.

Alignment orbit, coverage orbit, transmitter differential, and null checks are not required.

Final approach segments may be inspected inbound or outbound.

109.76 Shipboard TACAN

a. Emergency flight inspection procedures will normally be conducted by the Navy. Flight inspections to support specific missions will be requested by the Battle Group Commanders. Deployed ships requiring flight inspection should be positioned within 100 miles of a friendly airfield capable of supporting flight inspection aircraft. This positioning will aid mission completion within the operating service range of the flight inspection aircraft.

b. The flight inspection profile will include inspection of the approach radial from 20 NM to 3/4 NM. Any radial may be inspected outbound from approximately 10 NM while the ship makes required turns for stabilization check.

Checks Required	Tolerances/Procedures
Identification	Sufficient information to identify the facility. ID shall not render any parameter unusable.
Sensing and Rotation	Correct
Polarization	±4.0
Distance Accuracy	3% or 1.0 NM, whichever is greater
Approach	Alignment within $\pm2.5^{\circ}$. Structure not to exceed $\pm6.0^{\circ}$. 1/4 NM aggregate azimuth, DME unlock, or out-of-tolerance structure permitted. Inspected from FAF to MAP.
En Route	Alignment within $\pm4.0^{\circ}$. Structure not to exceed $\pm6.0^{\circ}$. 1.0 NM aggregate azimuth, DME unlock, or out-of-tolerance structure permitted in any 5 NM of radial flight.
Equipment Stability	Stability will be checked during radial inspection by requesting the ship to turn left 15° and then right 15°. Advise the ship's personnel of any change in azimuth or alignment during the turns (reference 203.7h1).
Standby Equipment	Will be checked by transponder change on approach and en route radials
Flyability	Any condition that may induce confusion will render that procedure or facility unusable

109.77 PAR

Checks Required	Tolerances/Procedures
Course Alignment	Sufficient to guide an aircraft down the runway centerline extended, within $\pm50'$ of runway centerline at threshold. Helicopter-only approaches require delivery to within 50' either side of desired touchdown point.
Glidepath Alignment	$\pm0.5^{\circ}$ of the commissioned angle. If PAR/ILS coincidence ($\pm0.2^{\circ}$) cannot be established, a NOTAM shall be issued.
Lower Safe Limit	Clear all obstacles to threshold
Coverage	Sufficient to meet operational requirements.
Range Accuracy	5% of true range and sufficient to determine when aircraft is over threshold
Flyability	Any condition that may induce confusion will render the facility unusable.

109.78 ASR/ATCRBS RADAR

Checks Required	Tolerances/Procedures
Azimuth Accuracy	En route--within $\pm5^{\circ}$ Approaches: 1. Straight-in within 500' of the edges of the runway at the MAP. 2. Approach to airport/ circling within a radius of the MAP which is 5% of the aircraft-to-antenna distance or 1000', whichever is greater.
Range Accuracy	Approach and en route within 5% of fix-to-station distance or 500' whichever is greater.
Coverage	Sufficient to support requirement. Targets of opportunity may be used by air traffic personnel. Standard vertical and horizontal coverage profiles not required.

109.79 DF Facilities

Checks Required	Tolerances/Procedures
Same as standard	See Section 212

109.80 Homing Beacons

Checks Required	Tolerances/Procedures
Identification	Sufficient information to identify the facility.
Coverage	En route--$\pm 15^{\circ}$ needle swing. Approach--$\pm 10^{\circ}$ needle swing. Sufficient signal to support required use.
Station Passage	Approximately over the station at all altitudes
Flyability	Any condition that may induce confusion will render the procedure or use unusable.

109.81 Communications. Conduct communications inspection concurrently with other inspections. User aircraft may be used.

109.80 Homing Beacons

Checks Required	Tolerances/Procedures
Identification	Sufficient information to identify the facility.
Coverage	En route--$\pm 15^{\circ}$ needle swing. Approach--$\pm 10^{\circ}$ needle swing. Sufficient signal to support required use.
Station Passage	Approximately over the station at all altitudes
Flyability	Any condition that may induce confusion will render the procedure or use unusable.

109.81 Communications. Conduct communications inspection concurrently with other inspections. User aircraft may be used.

CHAPTER 200. FLIGHT INSPECTION PROCEDURES

200.1 INTRODUCTION. Section 200 of this manual contains the specific flight inspection procedures for the individual facilities. Each procedure is subdivided for ready reference in the following manner:

2XX Facility Name

2XX.1 Introduction

2XX.2 Preflight Requirements

2XX.21 Facility Maintenance Personnel

2XX.22 Flight Personnel

2XX.3 Flight Inspection Procedures

2XX.31 Checklist

2XX.32 Detailed Procedures

2XX.4 Analysis

2XX.5 Tolerances

2XX.6 Adjustments

2XX.7 Records, Reports, and Notices to Airmen (NOTAM)

200.11 Units of Measurement.

a. All references to miles in this manual are in terms of nautical miles (NM). All bearing, heading, azimuth, and direction information and instructions are given in degrees relative to magnetic north, unless otherwise stated.

b. References to airspeeds are true unless otherwise stated. Air and ground speeds are given in and reported in knots. Altitude references are absolute (height above the site or terrain) unless otherwise stated.

TABLE OF CONTENTS, continued

SECTION 201. RHO THETA SYSTEMS

201.1 INTRODUCTION. Rho Theta Systems include Very High Frequency Omni-directional Range (VOR) and TACAN.

201.2 PREFLIGHT REQUIREMENTS.

201.21 Facilities Maintenance Personnel shall participate in the facility certification flight inspections and whenever adjustments are required (paragraph 106.31).

201.22 Flight Personnel. In addition to the preparation outlined in paragraph 106.32, the flight inspection personnel shall prepare charts, plot the position of the facility, and depict the orbit and radial checkpoints that will be used during the evaluations.

201.3 FLIGHT INSPECTION PROCEDURES.

a. An approved automated flight inspection system (AFIS) is the preferred method for conducting a facility flight inspection using procedures contained in appropriate agency directives. When using the AFIS to evaluate actual alignment of orbits or radials, the two following updating methods may be used.

(1) Global positioning system (GPS) hybrid (5 NM and beyond)

(2) Distance measuring equipment (DME) (10 NM and beyond)

b. When AFIS is not available, the evaluation procedures specified in this section shall be used.

c. When using a theodolite to evaluate facility performance, it shall be positioned and operated by a certified operator. The theodolite azimuth bearings shall be referenced to magnetic bearings "from" the facility (paragraph 201.44).

201.31 Checklist. The checklist prescribes the items to be inspected on each specific type of inspection.

RHO THETA SYSTEMS FLIGHT INSPECTION REQUIREMENTS

CHECK	REF. PARA 201.XXXX	SITE EVAL.	COMM	PERIODIC (5)	ANTENNA CHANGE	FREQUENCY CHANGE	GROUND REF ALIGN (3)	MAGVAR CHANGE	FACILITY ROTATE (2)
Reference Radial Check	201.3201		X		(3)	(3)		(3)	(3)
Monitors	.3202		(3)		(3)	(3)	(3)	(3)	(3)
En route Radials	.3203		X						
Intersection/Fixes Radials	.32031		X	(6)				X	(3) (7)
Terminal Radials	.32033	X	X	X, (4)	X	X		X	X
Orbits	.3204								
Coverage	.32041	X	X		(3)	X			
Alignment	.32042	X	X	(1) (4)	X	(3)	X	X	(2)
Ground Receiver Checkpoints	.3205		X	X	X			X	(2)
Airborne Receiver Checkpoint	.3206		X	X, (4)	X			X	(2)
Standby Transmitters	.3207 106.42		X	X		X		X	X

RHO THETA SYSTEMS FLIGHT INSPECTION REQUIREMENTS, CONTINUED

CHECK	REF. PARA 201.XXXX	SITE EVAL.	COMM	PERIODIC (4), (5)	ANTENNA CHANGE	FREQUENCY CHANGE	GROUND REF ALIGN (3)	MAGVAR CHANGE	FACILITY ROTATE (2)
Standby Power	.3208 106.43		X						
Associated NAVAIDs	.3209		X	X					
Identification	.41		X	X	X	X	X	X	X
Voice	.42		X	X		X			
Sensing and Rotation	.43	X	X	X	X	X	X	X	X
Course Sensitivity/ Modulation	.44	X	X	X	X	X	X	X	X
Polarization (one XMTR only)	.45	X	X	X	X	X		X	X
Frequency Interference	.46	X	X	X	X	X			
Course Structure	.47	X	X	X	X	X	X	X	X
Signal Strength	.48	X	X	X	X	X	X	X	X

FOOTNOTES:
(1) An alignment orbit (.32042) is required for all facilities every 900 days.
(2) Required if facility rotation is more than one degree.
(3) Maintenance request.
(4) Doppler Distributor Change - conduct on one transmitter only.
(5) Checklist requirements apply to facilities which support a SIAP or receiver checkpoint.
(6) Fixes depicted on a SIAP in final approach segment shall be evaluated concurrently with the SIAP.
(7) Facilities which support one or more intersections will require an evaluation of one intersection.

201.32 Detailed Procedures. Prior to performing the checks listed below, sensing and rotation must be verified (see paragraph 201.44)

201.3201 Reference Radial Check.

a. A reference radial shall be established during commissioning. It is recommended that a reference radial be established using an approach radial for the facility under evaluation. The radial should lie over a well defined ground reference checkpoint, on a theodolite bearing, or AFIS segment. When course roughness and scalloping occur during an alignment evaluation, the graphic average of the deviations shall be used.

b. A reference checkpoint for DME facilities shall be established as described in paragraph 201.32041.

201.3202 Monitor Reference Evaluation.

a. The monitor reference evaluation determines the minimum amount of azimuth course shift required to activate the ground facility monitor alarm system.

b. Monitor reference may be established either in the air or on the ground. Once established, the check shall become the reference for all subsequent checks. The procedure for establishing a monitor reference is as follows:

(1) With the course in the normal operating condition.

(2) With the course shifted to the monitor reference point.

(3) With the course shifted to the monitor reference point in the opposite direction from step (2) above.

(4) With the course returned to the normal operating condition.

NOTE: Step (4). There is no requirement that the course return to the measurement in Step (1). Monitor shifts of more than 1° will be brought to the attention of appropriate engineering personnel to determine if environmental or equipment related.

In each of these conditions, the course alignment will be compared by reference to recorded data to determine the amount of shift to the alarm point and to verify that it has returned to a normal condition.

c. Facilities that have dual parallel monitors require a monitor evaluation on one transmitter only. Facilities that have two individual monitors require evaluations on each transmitter.

201.3203 En route Radials

a. All radials supporting instrument flight procedures shall be checked for signal quality and accuracy. Fly the en route radials throughout the length of the intended use or facility flight inspection coverage requirement, whichever is greater. On "L" and "H" class facilities, fly the coverage radials at a minimum altitude of 1,000 feet (2,000 feet in designated mountainous terrain) above the highest terrain or obstruction to a distance of 40 miles or 25 miles for "T" class facilities. The 40-mile or 25-mile distances are considered the standard flight inspection coverage distances. If en route radials have coverage requirements beyond the previously mentioned flight inspection coverage distances, the radials shall be inspected to the additional distances at the minimum altitudes, unless otherwise requested.

b. Changeover Points. The minimum en route altitude (MEA) for an airway change-over point shall be the altitude where usable signals exist from all supporting stations. There is no requirement to check coverage beyond the COP.

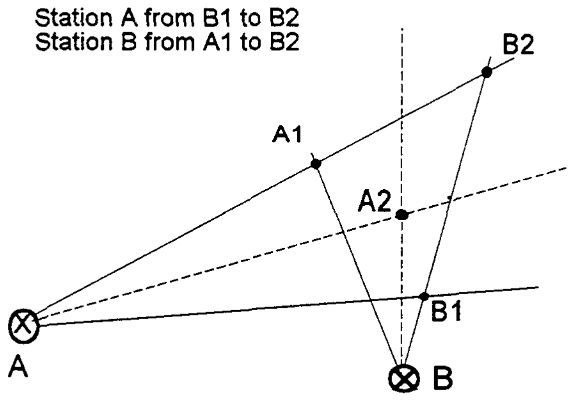
c. Evaluate azimuth alignment, course sensitivity or modulations, polarization, roughness and scalloping, bends, identification, voice features, sensing, and signal strength while flying the desired azimuth. Check for facility azimuth rotation while intercepting the radial.

201.32031 Intersection Radials.

a. Intersections are used to identify azimuth positions in space. These intersections can be used for navigational fixes, reporting points, COP, RNAV waypoints, etc. It is necessary to establish a MRA or MOCA for each intersection. The MRA is the lowest altitude where reliable signals can be received.

b. The stations are evaluated on the furthest side from each facility for each fix to ensure that usable signals exist. Evaluations of intersection radials shall include course sensitivity or modulations, identification, roughness and scalloping, alignment, and signal strength.

Evaluate Coverage



Evaluate azimuth alignment of the primary radials at A2.

The radials of the primary facility are evaluated at ± 4 miles or ± 4.5 degrees, whichever is greater. The crossing radial is evaluated at ± 3.6 degrees.

NOTE: If either facility can be the primary, then evaluate both at ± 4 miles or ± 4.5 degrees.

201.32032 Radials Identifying Fixes for Other Types of NAVAIDs.

a. These intersections may be reporting points, FAFs, MAPs, etc. MAPs shall be determined and evaluated at 100 feet below the published altitude. It is necessary to establish an MRA or MOCA for each intersection.

b. An evaluation is conducted while the aircraft is "on course" using the primary NAVAID for guidance. When using other types of NAVAIDs for primary course guidance, the radial is evaluated as a crossing radial (see paragraph .32031b). When the primary NAVAID is a localizer or localizer-type facility, crossing radial coverage will be evaluated on the extremity of localizer Sector 1 furthest from the VOR being evaluated (as in A1 to B2, paragraph .32031b).

c. Evaluate azimuth alignment, course sensitivity or modulations, identification, roughness and scalloping, and signal strength.

201.3204 Terminal Radials (Approach, Missed Approach, Transition STARs, SIDs).

a. Evaluate all the radial segments that comprise the STAR, SID, or SIAP. Ensure the procedure is compatible with human factors (see paragraph 214.43) and the navigational guidance is satisfactory. On commissioning inspections, the radials shall be evaluated to include the holding patterns, procedure turns, approach and missed approach, or departure routings. During periodic inspections of SIAPs, evaluate the final approach segment only. Evaluate other terminal radials on a surveillance basis.

b. All evaluations shall be conducted at the procedural altitudes except the final approach segment. This segment is evaluated from the FAF (or final descent point) descending to 100 feet below the lowest MDA to the MAP. During site, commissioning, reconfiguration, and certain other special inspections, evaluate VOR radials 5 degrees on each side of the final approach radial. Evaluate the offset VOR radials at the same altitudes as the final approach radial segment.

c. TACAN Null Checks will be flown as follows:

(1) Approved Procedure

(a) On commissioning inspections, antenna change, and new procedures, the following null checks are required:

1 Approach radial

2 5 degrees either side of the approach radial

The radials will be flown from 3 miles outside the final approach fix (FAF) to 3 miles inside the FAF at the lowest minimum altitude for FAF:

(b) Nulls, defined as any repeatable out-of-tolerance crosspointer action or condition of unlock usually accompanied by rapid changes in the automatic gain control (AGC) and oscilloscope indications of a loss or distortion of the 15 and 135 cycle modulation components, are not permitted in this area. If a null is found, measure the vertical angle by flight in the area described above at an altitude 500 feet above or below the minimum FAF altitude and inform maintenance so that the problem can be corrected if possible. If the null cannot be corrected by antenna change or height adjustment, a new procedure will be developed which will avoid the affected area. Null checks are required on only one transponder.

d. Commissioning Inspections. On commissioning inspections, missed approach and standard instrument departure (SID) radials for facilities which are located within the airfield boundary shall be evaluated from overhead the station outbound to the limits depicted for the procedure. If no termination point is depicted, the radial shall be checked to where it joins the en route structure or the expected coverage limit of the facility category, i.e., 25 miles for a "T" class and 40 miles for "L" or "H" class facilities.

e. Evaluate the radials for signal quality and accuracy. The SIAP final approach segment shall deliver the aircraft to a position where a satisfactory landing can be accomplished. Evaluate course sensitivity or modulations, polarization (when within 10 to 20 miles of the station), roughness and scalloping, bends, identification, and signal strength when flying the radials. Evaluate the 5-degree offset radials for course sensitivity or modulations, roughness and scalloping, spectrum analysis, identification, and signal strength.

201.32041 Distance Accuracy. Check the accuracy of the TACAN/DME distance information during inspection of the radials, orbits, approach procedures, and DME fixes. The exact mileage indication displayed on the distance indicators shall be noted on the recordings. Comparison of the scaled distance on the chart (converted to slant range) to the distance indicated by the TACAN/DME distance indicator at the various points may be made for accuracy determination.

a. It is not necessary to compute the slant range for distances measured at altitudes below a vertical angle of 5 degrees because the relative difference between slant and chart range is negligible (less than 1/2 to 1 percent).

b. For ease of computation, a 5-degree angle is equivalent to approximately 1,000 feet above the antenna at 2 miles and 5,000 feet above the antenna at 10 miles. Above a 5-degree angle, a DME slant range mileage shall be converted to chart distance.

201.32042 Erroneous Distance Information. If the ground facility is emitting false reply pulses, erroneous distance information may be present. This condition usually occurs within 25 miles of the antenna. Whenever actual false lock-ons are experienced, the offending facility shall be removed from service until this condition is remedied.

201.3205 Orbit Evaluations. Orbit evaluations are used to determine azimuth error distribution and signal quality. Orbit data are used as reference information. Ground checkpoints, theodolite, or AFIS may be used for azimuth references.

201.32051 Coverage Orbits.

a. This check is conducted primarily to obtain coverage data for site and commissioning inspections of "L" and "H" class facilities. The coverage requirements for the "T" class facilities do not require data beyond a distance of 25 miles. For "L" and "H" class facilities, one complete 40-mile orbit (one transmitter only) shall be flown on site and commissioning inspections.

(1) One thousand feet above the facility site elevation or intervening terrain (2,000 feet above the terrain in designated mountainous areas), whichever is higher.

(2) An altitude high enough to receive in-tolerance signals. If this altitude is higher than the altitudes in paragraph (1) above, a facility restriction and NOTAM are required for these areas. Areas of unsatisfactory coverage outside the SSV shall not constitute a facility restriction.

b. Expanded service volumes (ESVs) are required when they are procedurally used outside the standard service volumes.

c. During the orbit, evaluate azimuth alignment, course sensitivity or modulations, sensing and rotation, roughness and scalloping, identification, and signal strength (a minimum of 1 evaluation every 20 degrees).

d. Out-of-tolerance conditions discovered during orbital inspections shall be confirmed by a radial inspection before restricting a facility or issuing a NOTAM. The radial inspection results normally have priority over orbital inspection data.

201.32052 Alignment Orbit

a. **The alignment orbit** is used to determine the accuracy and optimum error distribution of the azimuth. The evaluation is conducted for 360 degrees of azimuth. An orbit radius of five nautical miles (NM) and beyond may be used when using global position system hybrid for updating and 10 NM and beyond when using distance measuring equipment updating. The orbit may be flown clockwise (CW) or counterclockwise (CCW), but once established, it shall be flown in the same direction on each subsequent inspection. Compute a tapeline altitude to fly the orbit at a standard angle of 4 to 6 degrees from the site. The objective of the check is to help facilities maintenance personnel determine environmental problems close in to the facility. The ratio between distance and altitude becomes critical when looking for low angle reflections or shadowing. Altitudes may be modified when conditions prevent establishing the altitude at the recommended 4 to 6 degrees (air traffic requirements, engineering or maintenance support, and site conditions). Indicate deviations from the standard on the flight inspection report. Maintain a ground speed that provides approximately 4 to 6 samples per degree for the orbit distance flown.

b. One orbit may be flown on dual transmitter facilities during any inspection, except commissioning, by requesting transmitter changes. If sufficient transmitter changes cannot be accommodated (at least one in every 90°), fly an orbit on each transmitter.

c. **During the orbit,** evaluate azimuth alignment, course sensitivity or modulations, sensing and rotation, roughness and scalloping, identification, and signal strength (a minimum of 1 evaluation every 20 degrees). Out-of-tolerance conditions found during an orbital inspection shall be confirmed by a radial evaluation before restricting a facility or issuing a NOTAM. The radial evaluations normally have priority.

d. **Course error distribution** must be determined prior to rotation (if required) to achieve optimum station balance. It is not necessary to refly the orbit after this facility rotation, provided the direction and magnitude of the adjustment can be confirmed. Candidate facilities for adjustment are determined by maximum error and error distribution rather than mean error. Adjustments will be made on the basis of analysis of flight inspection data to establish and maintain optimum error distribution. Course improvement adjustments shall be confirmed by flight inspection whenever the required course rotation is one degree or more. Course improvement adjustments do not require flight inspection, provided the course rotation is less than one degree. If a course improvement adjustment of more than one degree is required, contact facilities maintenance. Facilities maintenance will conduct an evaluation to determine if the change in the facility was caused by a maintenance problem or caused by an environmental change. When course improvement adjustments require confirming flight inspection, complete the checklist items for facility rotation (201.31).

201.3206 Ground Receiver Checkpoints

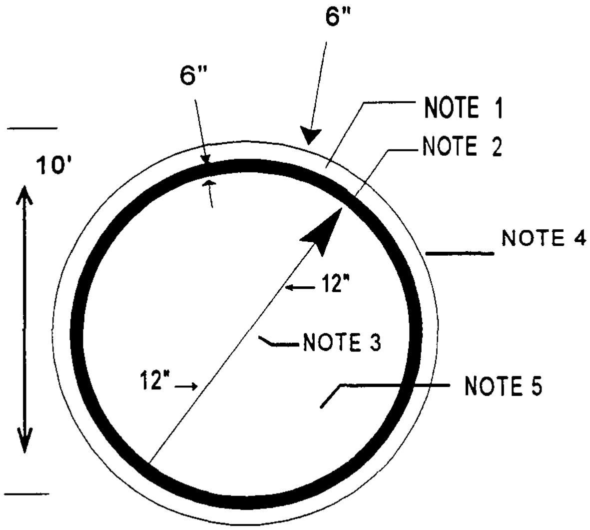
a. **Ground receiver checkpoints** will be established on the airport ramp or taxiways at points selected for easy access by aircraft, but where there will be no obstruction of other airport traffic. They normally will not be established at distances less than one-half mile from the facility, nor should they be established on non-paved areas.

b. **During the commissioning inspection,** align the aircraft toward the station with the aircraft receiving antenna over the selected point. Determine the correct facility radial and round off to the nearest whole degree. Position the aircraft receiving antenna alternately in three additional positions 90 degrees apart, and check for alignment stability. This radial will be published as the ground receiver checkpoint azimuth. Periodic flight inspections will be evaluated with the aircraft aligned toward the station and the receiving antenna over the checkpoint.

c. **All azimuth bearings** shall be stable and within prescribed azimuth tolerance. Evaluate azimuth alignment, course sensitivity or modulations, roughness and scalloping, identification, and signal strength. If a stable signal and alignment cannot be obtained at a location, select another site or establish an airborne receiver checkpoint.

d. Prior to publishing the ground receiver checkpoint, signs and airport surface markings shall be provided as described below. These signs shall be observed for continued maintenance during subsequent inspections of the facility.

(1) Airport Surface Markings. The spot selected for the checkpoint shall be marked by a painted circle 10 feet in diameter as illustrated below.



NOTES:

1. White.
2. Yellow (chrome yellow-taxiway aviation yellow).
3. Yellow. Arrow to be aligned toward the facility and extend the full width of the inner edge of the circle.
4. May be bordered on inside and outside with 6-inch black band if necessary for contrast.
5. Interior of circle black (concrete surfaces only).

(2) Signs. The receiver checkpoint signs shall show the facility identification, channel, course selected (published) for the check, and the plotted distance from the antenna.

Example:

DCA-VORTAC
116.3 (CH 110) 147/327
DME 1.5 NM

The signs shall be distinct and easy to read. The sign should have an overall mounting height of not less than 20 inches and not more than 30 inches. It shall be located on an extension of the diameter line and faced perpendicularly to the line-of-sight of the viewer in the circle. The sign shall not constitute a hazard to the operation of taxiing, landing, or departing aircraft.

201.3207 Airborne Receiver Checkpoint.

a. Airborne receiver checkpoints shall be designated over prominent ground checkpoints at specific altitudes. It is preferred that such checkpoints be near an airport so they are easily accessible to users. However, consideration should be given to selecting an area and altitude which will not interfere with normal traffic patterns.

b. The altitude specified for the receiver checkpoint shall be at least 1,000 feet AGL. The checkpoint should not be established at a distance less than 5 miles or more than 30 miles from the facility.

c. Fly the aircraft directly over the selected checkpoint either toward or away from the facility and mark the recording at the checkpoint. Compare the electronic radial recorded with the plotted geographic azimuth.

d. The electronic radial overlying the geographic checkpoint, rounded off to the nearest whole degree, will be the azimuth published as the receiver checkpoint.

e. The actual distance from the airborne receiver checkpoint to the antenna, as determined from a map study, shall be checked against the distance indication received when directly over the checkpoint.

201.3208 Standby Transmitters. Both transmitters (when installed) shall be evaluated for each required checklist item except the coverage orbit, which is required on one transmitter only. Alignment evaluations may be made by changing transmitters during an evaluation and comparing the azimuth course shift. Transmitter changes shall not be made inside the final approach fix; however, transmitter changes made before the final approach fix are satisfactory for evaluation purposes. If comparison results are questionable, fly the final approach segment on each transmitter.

201.3209 Standby Power

a. The following checklist items will be inspected while operating on standby power:

(1) Course alignment (one radial)

(2) Course structure

(3) Identification

(4) Distance accuracy

b. The inspections are to be performed when flying a portion of a radial with the station operating on normal power and then repeating the check over the same ground track with the station operating on standby power.

201.3210 Associated Facilities

a. Inspect associated facilities concurrently with the inspection of the primary facility. These include marker beacons, lighting aids, communications, etc., which support the en route/approach procedures and landing weather minimums of an associated approach procedure.

b. Conduct inspections of these facilities in conformance with the detailed procedures and tolerances contained in the applicable section of this manual.

201.4 ANALYSIS.

201.41 Identification (ID).

a. Identification Sequence

(1) VOR's, VOR/DME's, and VORTAC's with VOR voice identification using dual voice code reproducers at dual location or single voice code reproducer at single VOR location uses the following sequence:

Identification on VOR in code.

Identification on VOR by voice.

Identification on VOR in code.

Identification on TACAN/DME at the normal time for voice identification on the VOR.

(2) VOR's, VOR/DME's, and VORTAC's with VOR voice identification using single voice code reproducer with dual VOR equipment: The identification sequence is the same as in paragraph (1) above; however, synchronization will not exist between the TACAN and VOR identification. Voice identification may be heard with the keyed ident, and the flight inspector must determine from an operational standpoint if the identification is clear and that the course is not adversely affected.

(3) VOR's, VOR/DME's, and VORTAC's without VOR voice identification uses the following sequence:

Identification on VOR in code.

Identification on VOR in code.

Identification on VOR in code.

Identification on TACAN/DME at the normal time for code identification on the VOR.

b. Identification is a series of coded dots and dashes and/or voice identification transmissions that amplitude modulate the VOR RF carrier frequency. The ID enables a user to identify the VOR station.

c. **Evaluate the ID signals** for correctness, clarity, and to ensure there is no adverse effect on the azimuth course structure. When it is difficult to determine what effect the ID has on the azimuth course structure because of roughness and scalloping, evaluate the same azimuth radial with the ID off and compare the results. When simultaneous voice and Morse coded ID are installed, the modulation levels are adjusted so both audio levels sound the same. These levels are approximately 30 and 8 percent, respectively. When a voice broadcast feature is installed (ATIS, AWOS, etc.), the voice ID feature is suppressed during voice transmissions, but the Morse coded ID should still be heard. The Morse coded ID signals must be identifiable throughout the entire unrestricted VOR coverage area, including ESVs. When the identification is unacceptable, take appropriate NOTAM action and notify facility maintenance.

d. For facilities with standby transmitters and separate standby ID equipment, use the Morse coded ID to identify each transmitter. The number one transmitter has equal spacing between all characters of the coded identification. The spacing between the second and third characters of the number two transmitter is increased by one dot.

201.42 Voice.

a. The voice broadcast feature, when installed, allows a user to receive radio communications, weather and altimeter information, air traffic and airport advisories, etc. on the VOR frequency. Voice amplitude modulates the VOR carrier frequency by 30 percent.

b. Inspect the voice for clarity to ensure there is no adverse effect on the azimuth course. Ensure that all published remote sites can respond on the VOR frequency when contacted. Maintain a periodic surveillance of the quality and coverage of the voice transmissions throughout the VOR coverage area.

c. When the voice transmissions are unsatisfactory, but the remainder of the VOR operation is satisfactory, NOTAM only the voice feature out-of-service. When the voice modulation adversely affects the VOR operations, the voice portion must be disabled and NOTAMed out-of-service or the VOR shall be NOTAMed out-of-service.

201.43 Sensing and Rotation.

a. The sensing and the following rotation check are required at the beginning of the flight inspection. The position of the aircraft on a radial from the station must be known. Rotate the course selector (OBS, CDI, etc.) to the azimuth of the radial being flown. When the crosspointer is centered, the "TO-FROM" indicator will properly indicate "FROM" if sensing is correct. Sensing should be checked before rotation, as incorrect sensing may in itself cause the station rotation to appear reversed.

b. Rotation. Upon completion of the sensing check, conduct a partial counterclockwise orbit. The radial bearings shall continually decrease.

201.44 Course Sensitivity and Modulation Levels.

a. Course Sensitivity. The optimum course sensitivity of a VOR is plus or minus 10 degrees about a selected azimuth. TACAN sensitivity is preset $\pm 10^\circ$ in the receiver.

b. Modulation Levels. The three individual modulation levels associated with the VOR are: 30 Hz AM, the 30 Hz FM (or deviation ratio of the 9960 kHz subcarrier) and the 9960 kHz AM modulation of the VOR RF carrier.

(1) 30 Hz AM is optimized at 30 percent and is termed the "variable phase" on conventional VORs.

(2) 30 Hz FM (a deviation ratio of 16 is equivalent to 30 percent modulation value) is termed the "reference phase" on a conventional VOR. On Doppler VORs, it is termed the "variable phase."

(3) 9960 kHz AM is optimized at 30 percent. The 9960 kHz amplitude modulation of the VOR RF carrier may cause receiver flag warnings when out-of-tolerance.

Modulation values shall meet operational tolerances throughout the unrestricted service volume of a VOR. Determine the average modulation values or the graphical average of the recorded modulation values (when available) when fluctuations are encountered.

c. Analysis. Adjustments of modulation values may be made on any radial (within 10 to 25 miles of the facility).

201.45 Polarization.

a. Polarization causes azimuth course variations whenever the aircraft is banked around its longitudinal axis. It is caused by the radiation of a vertically polarized signal from the VOR antennas (horizontal polarization on TACAN) or other reflective surfaces around the site. The indications are similar to course roughness and scalloping, but normally can be separated by relating the course deviations to the aircraft banking. When roughness and scalloping cannot be separated from polarization, select another radial. The evaluations should be conducted on another nearby radial in the same azimuth quadrant.

b. Evaluation. Polarization should be evaluated any time a radial is checked and within 5 to 20 miles (inbound or outbound) from the facility. The preferred method of evaluating for polarization is to bank the aircraft 30 degrees around the longitudinal axis (starting on either side) returning to level flight momentarily, bank 30 degrees in the opposite direction and returning to straight and level flight. During the aircraft banking, the tracking and heading changes must be kept to a minimum. The course deviations that occur during the 30-degree rolls may indicate polarization.

If out-of-tolerance conditions are discovered using this method, a confirmation check using the methods prescribed in paragraph 201.45c is required. The indications of polarization may be influenced by course roughness and scalloping.

c. Confirmation Procedure. The polarization may be evaluated by the 30-degree bank, 360-degree turn method. This procedure is accomplished by flying over a prominent ground checkpoint (within 10 and 20 miles from the facility) executing a 30-degree bank and turn, and holding this attitude through 360 degrees, ending this maneuver as close to the same ground checkpoint as possible. While conducting this procedure, the recording should be marked at the beginning and end and at each 90-degree change in azimuth heading. If polarization is not present, the course will indicate a smooth departure from and return to the "on-course" position, deviating only by the amount that the aircraft is displaced from the original azimuth.

201.46 Spectrum Analysis.

a. The RF electromagnetic spectrum from 108 to 118 MHz is reserved for VOR and ILS localizer signals. Undesirable RF signals can be radiated in this frequency band that interfere with the VOR signals. Electromagnetic interference (EFI) signals can be produced by electrical manufacturing processes, power generating facilities, etc., which may be sporadic. Radio frequency interference (RFI) may be caused by other VORs, harmonics of other frequencies, FM stations, etc. which are usually continuous. The Regional Frequency Management and/or Spectrum Engineering Division are the primary offices responsible for predicting and evaluating frequency interference in the VOR frequency band.

b. The VOR spectrum shall be monitored for undesirable electromagnetic radiation when RF interference is suspected. When interfering radiation is observed, it is not justification for restricting the facility unless other flight inspection tolerances are exceeded. Undesirable signals shall be reported to Facilities Maintenance or the Regional Frequency Management and/or Spectrum Engineering Division. If facility restrictions and NOTAMs are established by frequency management studies or predictions, the origin of these restrictions shall be identified. These restrictions shall not be removed by flight inspection alone.

201.4601 Analysis of TACAN (Oscilloscope). The oscilloscope should be used for analysis of TACAN signals. The following are suggested analytical procedures, and no facility restrictions are to be applied if adjustment cannot be made or if maintenance personnel are not available for adjustment. The composite video, when displayed on the oscilloscope, will yield considerable data about the TACAN facility. The oscilloscope may be used to measure the following composite video parameters:

(1) 15 Hz modulation

(2) 135 Hz modulation

(3) Identification train

(4) Reflections

(5) MRG size

(6) Auxiliary Reference Group (ARG) size

(7) ARG count

201.4602 Modulation Percentage 135 and 15 Hz. Measure the modulation of each component measured from the composite video and calculate the modulation percentage (see Section 302).

a. Modulation measures are more easily and accurately made by the TACAN test set. The oscilloscope should be used only when the TACAN test set is not available for use.

b. Identification Train. To measure the ident spacing group, adjust the oscilloscope so that the main burst is on the left edge of the graticule and the first auxiliary burst is on the right edge. When the ident is on, the reference bursts and the ident groups become very evenly spaced, and a group should appear on each division line.

c. Reflections. Reflected signals may be detected by examining the composite video. Reflections, when present, may duplicate the normal pattern in an image pattern slightly displaced to the right. Reflections may be of sufficient amplitude to cause the pattern amplitude to oscillate or cause the modulation percentage to oscillate at a sine wave frequency dependent on velocity and position of the aircraft.

d. Main Reference Group Size. Size refers to the number of pulse pairs in a group. For "X" channel, there should be 12 pulse pairs in the main reference group spaced 30 usec apart with spacing of each pulse in a pair of 12 usec. For "Y" channel, there are 13 single pulses in the MRG spaced 30 usec apart. If the TACAN test set indicates a discrepancy in the group size, use of the oscilloscope will identify the trouble. Advising maintenance of the condition found will greatly ease their task of correcting the problem.

e. Auxiliary Reference Group Size. Size refers to the number of pulse pairs in an auxiliary reference group. For "X" channel, there should be six pulse pairs spaced 24 usec apart with spacing of each pulse in a pair of 12 usec. For "Y" channel, there are 13 single pulses in a group spaced 15 usec apart. If the TACAN test set indicates a discrepancy in the group size, use of the oscilloscope will identify the trouble. Advising maintenance of the condition will ease their task of correcting the problem.

f. Auxiliary Reference Group Count. Count refers to the number of auxiliary reference groups between North reference bursts or groups. There are eight auxiliary reference groups between North reference bursts. If the TACAN test set shows the loss of auxiliary reference groups, use of the oscilloscope will quickly identify the exact problem. Advising maintenance of the condition will greatly ease their task of correcting the problem.

g. Operational Limits. Oscilloscope measurements should fall within the following limits:

Parameters	Limit	Remarks
15 Hz Modulation	12 to 30 percent	Antennae with modulation greater than 30 percent are in use.
135 Hz Modulation	12 to 30 percent	If no derogation of facility performance exists, these limits may be ignored but advise maintenance.
Identification pulse spacing	740 microseconds	Synchronized with burst.
Reflections	N/A	No derogation of facility performance.
MRG size	12 ± 1 pulse pair	
ARG size	6 ± 1 pulse pair	
ARG count	8 ± 0 burst	

201.47 Course Structure

a. Roughness, scalloping, and bends are displayed on the recorder charts as deviations of the crosspointer (course deviation indicator) recording trace. Roughness will show a series of ragged irregular deviations; scalloping as a series of smooth rhythmic deviations; and the frequency of each is such that it is not flyable and must be "averaged out" to obtain a course.

b. To measure the amplitude of roughness and scalloping, or the combination, draw two lines on the recording which are tangential to and along each positive and negative peak of the course deviation. The number of degrees or microamperes between these lines will be the total magnitude of course deviations; one-half of this magnitude will be the plus and minus deviations.

c. The third line is drawn equidistant from these lines to obtain the average "on course" from which course alignment is measured. Thus, the alignment error of the course may be computed from the course recordings at any point where an accurate checkpoint has been marked on the recording. Alignment error will be referred to in degrees to the nearest tenth. Misalignment in a clockwise direction is considered positive. Where the magnetic azimuth of the measured (ground) checkpoint is greater than the electronic radial, the error is positive.

d. A bend is similar to scalloping except its frequency is such that an aircraft can be maneuvered throughout a bend to maintain a centered crosspointer. Accordingly, a bend might be described as a brief misalignment of the course. Bends are sometimes difficult to discern, especially in those areas where good ground checkpoints or other means of aircraft positioning are not available. It is, therefore, important to the analysis of a bend to consider aircraft heading and radial alignment deviations.

A smooth deviation of the course over a distance of two miles would manifest itself as a bend for a flight inspection aircraft at a ground speed of 150 knots. An aircraft of greater speed would not detect such smooth deviations of the course as a bend unless it were over a greater distance. In the analysis of bends, further consideration should be given to the flight levels and speeds of potential users. Since speed, altitude, system response, and other factors are important in the analysis of course structure, the flight inspector should carefully evaluate the flyability factor before assigning a final facility classification.

201.48 Signal Strength. During all flight inspection evaluations, the received signal shall be equal to or greater than the specified tolerance.

201.5 TOLERANCES. Facilities that meet tolerances throughout the flight inspection SSV are classified as UNRESTRICTED. Facilities that do not meet tolerances in the flight inspection SSV are classified as RESTRICTED. Appropriate NOTAM action shall be taken to notify the user of the unusable areas (see Section 107). Facilities which do not meet tolerances beyond the flight inspection SSV shall not be restricted; however, procedural use shall be denied.

201.51 VOR Tolerances

a. Identification. Morse code and voice identification shall be correct, clear, and identifiable. The audio levels of the Morse code and voice shall sound similar. The course structure shall not be affected by the identification.

b. Voice. Voice transmissions (when installed) shall be clear and understandable. Simultaneous voice transmissions and Morse code identification shall sound similar. The voice identification shall be suppressed during voice transmissions. Voice transmissions shall not cause more than ± 0.5 degrees of course deviations.

c. Sensing and Rotation. The "To/From" sensing shall be "From" when positioned on a selected radial, and the bearings shall decrease in a counter clockwise direction around the station.

d. Course Sensitivity and Modulation Levels.

(1) Course sensitivity shall be 20 ± 2 degrees.

(2) Modulations.

(a) 30 Hz AM shall be 30 ± 5 percent.

(b) 30 Hz FM shall be 30 ± 5 percent or 16.0 ± 1.2 when expressed as a deviation ratio.

(c) 9960 kHz shall be 20 to 35 percent on transmitters with voice modulation and 20 to 55 percent on transmitters without voice modulation.

e. Polarization. The effects of polarization shall not exceed 2 degrees.

f. Radials. Alignment and Course Structure:

(1) Alignment of all electronic radials shall not exceed ± 2.5 degrees of the correct magnetic azimuth.

(a) Reference radial alignment shall be established not to exceed ± 1.0 degree of the correct magnetic azimuth.

(b) Deviations of the course due to bends shall not exceed 3.5 degrees of the correct magnetic azimuth and shall not exceed 3.5 degrees from the average electronic radial alignment.

(2) Course Structure:

(a) Roughness/scalloping: Momentary deviations from the on course shall not exceed ± 3.0 degrees when alignment meets the criteria of 201.51f(1).

(b) Course aberrations. Deviations of the course greater than 3.0 degrees are acceptable for en route radials, provided the aggregate area does not exceed the following:

1 0.25 NM in any 5 NM segment from sea level up to 10,000 feet MSL.

2 0.5 NM miles in any 10 NM segment from 10,001 feet to 20,000 feet MSL.

3 1.0 mile in any 20-mile segment above 20,000 feet MSL.

(c) Flyability. The effects of any one, or combination of any alignment and/or course structure criteria, even though in tolerance, shall not render the radial unusable or unsafe.

g. Signal Strength. Signal strength is satis-factory when the received RF signal equals or exceeds 5 microvolts or -93 dbm. Ground receiver checkpoints require a minimum of 15 microvolts or -83 dbm.

h. Receiver checkpoints.

(1) Airborne receiver checkpoints. All parameters shall meet tolerances, and the alignment shall be within ± 1.5 degrees of the published azimuth.

(2) Ground Receiver Checkpoints. All parameters shall meet tolerances except the minimum acceptable signal strength is 15 microvolts or more, and the alignment shall be within ± 2.0 degrees of the published azimuth.

i. Monitor. The transmitter azimuth monitor reference shall be ± 1.0 degree.

j. Standby Equipment. The standby transmitter shall meet all tolerances, and the difference in azimuth alignment between transmitters shall not exceed 2.0 degrees.

k. Standby Power. Operation on standby power shall not cause any parameters to exceed tolerances.

l. Associated Facilities. Reserved.

201.52 TACAN Tolerances

a. Course Sensitivity. No facility tolerance applicable.

b. Identification. Code identification shall be correct, clear, distinct, without background noise, and not affect course characteristics throughout the coverage limits of the facility. TACAN/DME identification shall be correctly sequenced with the VOR identification when collocated as a VORTAC.

c. Sensing and Rotation. Sensing and rotation shall be correct.

d. Reference Checkpoint. No specific tolerances apply. If the alignment at this checkpoint has changed more than 1.0 degrees since last established, it will be necessary to check the monitor (see paragraph 201.3202).

e. Distance Accuracy shall be within 0.25 NM plus 1.25 percent of the slant distance.

f. Radials. Alignment and course structure:

(1) Alignment of all approach radials shall not exceed ± 2.0 degrees of the correct magnetic azimuth.

(2) Alignment of all other electronic radials shall not exceed ± 2.5 degrees of the correct magnetic azimuth.

(a) Reference radial alignment shall be established not to exceed ± 1.0 degree of the correct magnetic azimuth.

(b) Deviations of the course due to bends shall not exceed 3.5 degrees of the correct azimuth and shall not exceed 3.5 degrees from the average electronic radial alignment.

(3) Course structure:

(a) Roughness/scalloping: Momentary deviations from the on course shall not exceed ± 3.0 degrees when alignment meets the criteria of 201.51f(1).

(b) Course abberations. Deviations of the course greater than 3.0 degrees are acceptable for en route radials, provided the aggregate area does not exceed the following:

1 0.25 NM in any 5 NM segment from sea level up to 10,000 feet MSL.

2 0.5 NM in any 10 NM segment from 10,001 feet MSL to 20,000 feet MSL.

3 1.0 NM in any 20 NM segment above 20,001 MSL.

(c) Flyability. The effects of any one, or combination of any alignment and/or course structure criteria, even though in tolerance, shall not render the radial unusable or unsafe.

(4) Unlocks.

(a) Approach radials. No condition of azimuth or distance unlock is permitted while evaluating the approach procedure, including the missed approach, as published. The only exception would be normal passage through the station cone.

(b) En route radials. No more than one condition of azimuth unlock not to exceed 1 NM in a 5 NM segment and/or condition of distance unlock not to exceed 1/2 NM in a 5 NM segment.

g. DME fixes. See paragraph 201.52e.

h. Orbits. See paragraph 201.3204.

i. Coverage. Coverage shall be at the standard service volume of the facility being checked as determined by existing criteria for terrain and obstacle clearance. Exception — coverage for "T" (Rho Theta) facilities will be 25 miles. The standard recommended signal strength is 22 μV or higher. However, the lack of 22 μV shall not be the sole determination for restricting or removing a facility from service if a solid stable DME or azimuth lock-on is present.

j. Frequency Interference. Frequency interference shall not derogate facility performance to the extent that the pilot cannot audibly identify the facility or cause out-of-tolerance conditions on the TACAN course and distance information.

k. Receiver Checkpoints.

(1) Airborne Receiver Checkpoint. Course alignment shall be within 1.5 degrees of the published azimuth. Distance accuracy must be within the tolerance specified in paragraph 201.52e.

(2) Ground Receiver Checkpoints. The ground receiver checkpoints must meet the following tolerances:

(a) Course alignment must be within 1.5 degrees of the published azimuth.

(b) Distance indication must be within 0.2 miles of the measured distance.

(3) Inability of the facility to provide a ground or airborne receiver checkpoint according to the tolerances specified above shall not cause a restriction to be placed on the facility.

l. Monitor. The transmitter azimuth monitor reference shall be ± 1.0 degree.

m. Polarization Effect. The maximum deviation of the course caused by the effects of horizontal polarization is ± 2.0 degrees.

n. Standby Equipment. Operative standby and primary equipment will meet the same tolerances. The difference in the alignment of the course formed by each transmitter shall be within 1.5 degrees. Distance differential between transmitters shall not exceed 0.2 miles.

o. Standby Power. Tolerances for a facility on standby power shall be the same as those on primary power.

p. Associated Facilities. The tolerances contained in other appropriate sections of the manual are applicable to associated facilities.

201.53 SHIPBOARD TACAN

a. Introduction. Flight inspection of shipboard TACAN shall be performed when requested by the U.S. Navy. Due to the deployment of ships, these inspections shall be considered a one-time inspection and shall include all checklist items in paragraph 201.5301.

b. The flight inspection shall be scheduled upon receipt of the following information:

(1) Date and time of requested inspection.

(2) Name and hull number of the ship.

(3) TACAN channel.

(4) UHF primary and secondary communication frequency.

(5) Location of ships (latitude and longitude).

(6) Name and phone number (FTS and/or AUTOVON) of area coordinator.

c. The inspection shall be conducted with the ship underway and at a distance from shore that is sufficient to preclude interference or shielding of the signal by land mass during radial and orbital inspections.

d. The ship's radar shall be used as a basis to determine alignment. Fire control radar is considered the most accurate and will be used when available. Search (CIC) radar may be used if fire control radar is not available. Fire control information is given as TRUE bearings and search radar is MAGNETIC.

e. Due to various antenna mount positions on ships and possible shielding by other antennas, masts, etc., nulls, and/or unusable sectors may occur. Suspected out-of-tolerance conditions shall be confirmed by a second evaluation of the area in question. Any sector of the TACAN that does not provide azimuth or distance information shall be reported immediately to the ship and documented in the flight inspection report.

201.5301 CHECKLIST. The following shall be inspected during shipboard inspections.

a. Identification.

b. Sensing and rotation.

c. Polarization.

d. Radial alignment (minimum of one).

e. Coverage.

f. Distance accuracy.

g. Frequency interference.

restricting or removing a facility from service if a solid stable DME or azimuth lock-on is present.

j. Frequency Interference. Frequency interference shall not derogate facility performance to the extent that the pilot cannot audibly identify the facility or cause out-of-tolerance conditions on the TACAN course and distance information.

k. Receiver Checkpoints.

(1) Airborne Receiver Checkpoint. Course alignment shall be within 1.5 degrees of the published azimuth. Distance accuracy must be within the tolerance specified in paragraph 201.52e.

(2) Ground Receiver Checkpoints. The ground receiver checkpoints must meet the following tolerances:

(a) Course alignment must be within 1.5 degrees of the published azimuth.

(b) Distance indication must be within 0.2 miles of the measured distance.

(3) Inability of the facility to provide a ground or airborne receiver checkpoint according to the tolerances specified above shall not cause a restriction to be placed on the facility.

l. Monitor. The transmitter azimuth monitor reference shall be ± 1.0 degree.

m. Polarization Effect. The maximum deviation of the course caused by the effects of horizontal polarization is ± 2.0 degrees.

n. Standby Equipment. Operative standby and primary equipment will meet the same tolerances. The difference in the alignment of the course formed by each transmitter shall be within 1.5 degrees. Distance differential between transmitters shall not exceed 0.2 miles.

o. Standby Power. Tolerances for a facility on standby power shall be the same as those on primary power.

p. Associated Facilities. The tolerances contained in other appropriate sections of the manual are applicable to associated facilities.

201.53 SHIPBOARD TACAN

a. Introduction. Flight inspection of shipboard TACAN shall be performed when requested by the U.S. Navy. Due to the deployment of ships, these inspections shall be considered a one-time inspection and shall include all checklist items in paragraph 201.5301.

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d. The ship's radar shall be used as a basis to determine alignment. Fire control radar is considered the most accurate and will be used when available. Search (CIC) radar may be used if fire control radar is not available. Fire control information is given as TRUE bearings and search radar is MAGNETIC.

e. Due to various antenna mount positions on ships and possible shielding by other antennas, masts, etc., nulls, and/or unusable sectors may occur. Suspected out-of-tolerance conditions shall be confirmed by a second evaluation of the area in question. Any sector of the TACAN that does not provide azimuth or distance information shall be reported immediately to the ship and documented in the flight inspection report.

201.5301 CHECKLIST. The following shall be inspected during shipboard inspections.

a. Identification.

b. Sensing and rotation.

c. Polarization.

d. Radial alignment (minimum of one).

e. Coverage.

f. Distance accuracy.

g. Frequency interference.

SECTION 202. VOR TEST FACILITY (VOT)

CROSS INDEX

Approved Procedure. For both standard and area VOT's, check and record the identification for correctness, clarity, and possible effects on the course indications throughout the areas of intended use (both in the air and on the ground).

202.3203 Sensing. This check determines and/or establishes the correct ambiguity of the transmitted signal.

Approved Procedure. While on the ground or in the air, check that the ambiguity indicates TO with 180^{o} set in the omnibearing selector (OBS) and FROM with 360^{o} set in the OBS, throughout the areas of intended use.

202.3204 Modulation Level. Since minor variations of the 30Hz AM, 30Hz FM, and 9960 will effect flight data, check the modulation levels throughout the areas of intended use. Measure and record modulation levels during all inspections.

Approved Procedure.

(1) Ground. Establish nominal values at the VOT reference point. Ensure that modulations remain within tolerance throughout all use areas.

(2) Airborne. Ensure that modulations remain in tolerance throughout all areas while conducting coverage maneuvers.

202.3205 VOT Reference Point. This check provides a designated area to begin an inspection or verify facility performance.

Approved Procedure

(1) Standard VOT. This check should be performed on the ground. Position the aircraft in an area of normal use for the VOT. It is recommended that the area chosen be the furthest distance from the facility maintaining line of site. Ensure signal quality and alignment are satisfactory in accordance with paragraph 202.5 When ground measurements are not practical, use the procedures outlined in paragraph 202.3205(2) to establish the reference point.

(2) Area VOT. This check may be performed on the ground or in the air. Position the aircraft over a known geographical point at the furthest point of intended use from the facility while maintaining line of site. Ensure signal quality and alignment are satisfactory in accordance with paragraph 202.5.

202.3206 Alignment. This check is performed to establish and/or verify the accuracy of the transmitted VOT courses throughout the coverage areas.

Approved Procedure. Establish the VOT course alignment at its optimum value (zero degree course error) at the VOT reference point.

(1) Commissioning. Use the procedure described in paragraph 202.3205(1).

(2) Periodic. Inspect the alignment of the VOT anywhere within the approved use areas. If the station alignment exceeds the tolerances specified in paragraph 202.5, recheck and reestablish the alignment (and monitors if necessary).

202.3207 Coverage. The purpose of this check is to ensure that adequate signal is received in all areas of intended use.

a. **Approved Procedures.**

(1) Standard VOT. Coverage is evaluated during a commissioning inspection concurrent with establishing the standard VOT Reference Point (see paragraph 202.3205(1)). For periodic inspections, evaluate coverage anywhere within the approved use area.

(2) Area VOT. Identify all the airports that the area VOT is to serve. Evaluate VOT performance at these airports in the air and/or ground, depending on air or ground use.

(a) Ground coverage is evaluated during a commissioning inspection concurrent with establishing the area VOT Reference Point (see paragraph 202.3205(2)). For periodic inspections, evaluate coverage anywhere within the approved area.

(b) Airborne Coverage. Airborne coverage is evaluated during the commissioning inspection concurrent with establishing the approved use area. Since there is no standard service volume, the area is predicated on the need for VOT service, facility performance, and frequency protection. The most beneficial service can be provided by establishing an approved use area which is a fixed radius around the VOT site, normally 10 to 15 miles. An alternative to this method would be to fly a separate 3-mile orbit around each airport where VOT service will be provided.

(c) Inspections. During the commissioning inspection, fly the orbits at the minimum and maximum altitudes at which VOT use will be authorized, normally between 1,000 and 5,000 feet. On periodic inspections, evaluate facility performance anywhere within the approved use area.

b. Restrictions to Coverage. Notify appropriate airport personnel of any areas within line-of-sight of the VOT in which sufficient signal is not available, then comply with paragraph 107.3

202.3208 Monitor. This check assures that a valid course is transmitted within specified values. For flight inspection purposes, the remote alarm unit shall be considered a part of the monitor.

Approved Procedure. Conduct this check at the VOT reference point or at any point on the airport where a valid signal is received.

(1) Have facilities maintenance personnel shift the course until the alignment monitor alarms. Record and measure the course.

(2) Have facilities maintenance personnel shift the course in the opposite direction until the alignment monitor alarms. Record and measure the course.

(3) Have facilities maintenance personnel return the course to normal. Record and measure the course.

202.3209 Standby Power. See paragraph 106.43.

202.4 Analysis. See paragraph 106.5.

separate 3-mile orbit around each airport where VOT service will be provided.

(c) Inspections. During the commissioning inspection, fly the orbits at the minimum and maximum altitudes at which VOT use will be authorized, normally between 1,000 and 5,000 feet. On periodic inspections, evaluate facility performance anywhere within the approved use area.

b. Restrictions to Coverage. Notify appropriate airport personnel of any areas within line-of-sight of the VOT in which sufficient signal is not available, then comply with paragraph 107.3

202.3208 Monitor. This check assures that a valid course is transmitted within specified values. For flight inspection purposes, the remote alarm unit shall be considered a part of the monitor.

Approved Procedure. Conduct this check at the VOT reference point or at any point on the airport where a valid signal is received.

(1) Have facilities maintenance personnel shift the course until the alignment monitor alarms. Record and measure the course.

(2) Have facilities maintenance personnel shift the course in the opposite direction until the alignment monitor alarms. Record and measure the course.

(3) Have facilities maintenance personnel return the course to normal. Record and measure the course.

202.3209 Standby Power. See paragraph 106.43.

202.4 Analysis. See paragraph 106.5.

SECTION 203

RESERVED

SECTION 204. VISUAL GLIDE SLOPE INDICATOR

CROSS INDEX

Paragraphs	Title	Pages

SECTION 204. VISUAL GLIDE SLOPE INDICATOR

CROSS INDEX

SECTION 204. VISUAL GLIDE SLOPE INDICATOR (VGSI)

204.1 Introduction.

a. The Visual Glide Slope Indicators (VGSI) are ground devices that use lights to define a vertical approach path during the final approach to a runway. The visual signal shall consist of not less than two and not more than four colors. Allowable colors are red, yellow, green, or white. Color sectors shall be distinct and identifiable throughout the horizontal beam width at all intensity settings. Only red is used to indicate the lowest below-path sector of the system.

b. The final approach area for VGSI's is 10° either side of the runway centerline extended, measured from the forward most bar or light extending from the threshold outward to a point a normal glidepath can commence from the en route or procedural altitude. VGSI's are aligned to provide a glidepath not less than 1.0° above obstacles 10° either side of the runway centerline to a distance of 4 miles. Lateral guidance is obtained by reference to either visual cues or electronic aids.

c. Threshold crossing height (TCH) is the height of the lowest on-path signal at the threshold. The minimum TCH is determined by the most critical aircraft that normally operates on the runway. The TCH of VGSI's will normally be 25 to 75 feet. Specific TCH criteria for each type system is located in FAA Order 6850.2, Visual Guidance Lighting Systems.

d. There are several different types of VGSI's. The primary systems covered in this section are visual approach slope indicators (VASI), precision approach path indicators (PAPI), and pulsating visual approach slope indicators (PVASI). Each of these systems presents a different type of visual indication to the pilot and requires different inflight interpretation.

204.11 Visual Approach Slope Indicator System (VASI).

a. The VASI consists of either two or three light bars placed perpendicular to the runway. The light bars consist of one, two, or three boxes aligned on the left or both sides of the runway. Each box contains three high intensity lamps behind a horizontally divided filter with red colored and clear portions.

b. In using the systems, a pilot should fly *through the light bar nearest the runway* threshold (number 1 bar) until it appears WHITE, and undershoot the light bar beyond the touchdown point (number 2 bar) until it appears RED. The aircraft will be on the visual glide slope when the number 2 light bar appears RED and the number 1 light bar appears WHITE. When the aircraft deviates from visual glidepath, the pilot will see a change in color of one of the light bars. Deviation above the established glidepath will cause the number 2 light bar to fade from RED, through PINK, to WHITE, with the total change occurring within $1/4^{\circ}$ to $1/2^{\circ}$. Deviation below the glidepath will cause the number 1 light bar to change from WHITE, through PINK, to RED, within $1/4^{\circ}$ to $1/2^{\circ}$. A pilot sees two WHITE bars above glidepath and two RED bars below glidepath.

c. There are three basic configurations of VASI that are described below:

(1) Left Side of Runway.

(a) VASI-2 consists of two light boxes as shown in Figure 204-A. This system provides descent information under daytime conditions to a distance of 3 miles.

(b) SAVASI-2 consists of two light boxes with a single lamp in each box as shown in Figure 204-A. This system is designed for nonjet, utility airports, and provides descent information under daytime conditions to a distance of 1.5 miles.

(c) VASI-4 consists of four light boxes installed as shown in Figure 204-B. This system provides descent information under daytime conditions to a distance of 4 miles.

(2) **Both Sides of Runway.**

(a) **VASI-12 consists of 12 light boxes installed as shown in Figure 204-C.** This system provides descent information under daytime conditions to a distance of 5 miles.

(b) **VASI-8 consists of eight light boxes installed as shown in Figure 204-C.** This system is basically the 12-box system with the outer four boxes removed and provides descent information under daytime conditions to a distance of 5 miles.

c. **Walker 3-Bar System.**

(1) **Walker 3-Bar VASI-6 is a 3-bar system installed as shown in Figure 204-E.** Each bar consists of two light boxes aligned on the left side of the runway. The system provides descent information under daytime conditions to a distance of 3 miles.

(2) **Walker 3-Bar VASI-16 consists of 16 light boxes installed as shown in Figure 204-F.** The system is basically a VASI-12 with the addition of a 2-box light bar on each side of the runway which provides an additional visual glidepath at a higher angle. The lower path is designed for large aircraft. This system provides descent information under daytime conditions to a distance of 5 miles.

204.12 Precision Approach Path Indicator System (PAPI).

a. **The PAPI uses a two-color light projector system** that produces a visual glidepath as shown in Figure 204-H. Each light box consists of at least two optical projectors that produce a single beam of light, the upper part of the beam is WHITE and the lower part RED. When passing through the beams, the transition from one color to the other is almost instantaneous.

b. **There are two basic configurations of PAPI's that are described below:**

(1) **Four-Box System.** The glidepath angle of a 4-box system is the midpoint of the angular setting of the center pair of light boxes. The on-path width is the difference between the angles of light boxes 2 and 3. Normal installation requires 0.33° between light box settings 1 and 2, 2 and 3, and 3 and 4. Systems that support large aircraft require 0.50° between light boxes 2 and 3. The on-glidepath indication is two RED and two WHITE lights on the light bar. When the aircraft goes below the glidepath, the pilot sees a progressively increasing number of RED lights, and if the aircraft goes above the glide slope, the number of WHITE lights increases as shown in Figure 204-I. This system provides descent information under daytime conditions to a distance of 4 miles.

(2) **Two-Box System.** This system is designed for utility type airports. The glidepath angle is the midpoint between the angular setting of the two light boxes. The on-path width of this system is normally 0.50°, but may be reduced to provide obstacle clearance. The on-glidepath indication is one RED and one WHITE light. When the aircraft goes below the glidepath, the pilot sees two RED lights and two WHITE lights above glidepath. This system provides descent information under daytime conditions to a distance of 2 miles.

204.13 Pulsating Visual Approach Slope Indicator System (PVASI). PVASI's normally consist of a single light unit projecting a two-color visual approach path as shown in Figure 204-J. The below glidepath indication may be pulsating or steady RED, and the above glidepath indication is normally pulsating WHITE. The above and below path pulsating lights appear to pulse faster the farther off path the pilot flies. The on-glide-path indication for one system is a steady WHITE light, and for another system the on-glide-path indication is an alternating RED and WHITE light. The on-path width of the steady WHITE light is approximately 0.35° wide. This system provides descent information under daytime conditions to a distance of 4 miles.

204.2 Preflight Requirements.

204.21 Ground. In addition to preparations specified in Section 106.21, the facilities maintenance personnel shall:

a. **Ensure that all lamps are operating.**

b. **Check the lamps for blackening and the lenses for cleanliness.**

c. **Check the setting of each box to determine proper angular adjustment.**

d. **Inform the flight inspection personnel of any unique siting conditions such as visual screening, waivers, or local restrictions.**

204.22 Air. The flight inspector will comply with the preparations specified in Section 106.22. The flight inspector should review installation instructions and criteria contained in other appropriate directives.

204.3 Flight Inspection Procedures. Initial settings are determined by ground adjustments and verified by flight inspection. Flight inspection checks the overall appearance and usability of the system as viewed by the pilot on the approach, checks for coincidence of the VGSI's with other NAVAID's serving the same runway, and confirms obstacle clearance. Some of the detailed procedures below are type specific; adaptation of these procedures may be required for new or modified equipment types.

204.31 Checklist. Conduct a commissioning flight inspection when either a waiver is required or Airway Facilities or Airports Division makes a request. A commissioning inspection is required for all military facilities. Ground maintenance inspections maintain the VGSI's within operational tolerances, augmented by airborne surveillance inspections. Accomplish airborne surveillance inspections during routine inspections of nearby or associated primary navigation aids. There are no requirements to conduct periodic flight inspections of VGSI's.

Type Check	Ref. Para	Comm.	Surveil-lance
Light Intensity	204.321	X	X
Glidepath Angle	204.322	3	1, 3
Angular Coverage	204.323	X	
Obstruction Clearance	204.324	X	2
System Identification/ Contrast	204.325	X	X
Radio Control	204.326	X	X
Coincidence (ILS/MLS/PAR)	204.327	X	X

FOOTNOTES:

1 Check when coincidence with other NAVAID's has changed or other abnormalities are observed.

2 Check when new construction or questionable obstructions are identified in the final approach area.

3 Glidepath angle verification of FAA and Airport Improvement Program (AIP) funded VGSI's installed and ground checked using an FAA-approved aiming device, is not required unless requested.

204.32 Detailed Procedures.

204.321 Light Intensity.

a. General. Depending on the type of VGSI's and system design, the light intensity can be either manually or automatically controlled for daylight or darkness operations Some systems have three settings which allow for daylight, twilight, and dark operations. Maintenance can select one or two options for night operations to accommodate local site conditions for some systems.

b. Positioning. For facilities that are manually controlled, fly inbound while the controller changes the intensity settings to all operating ranges. Systems that use the automatic intensity settings should be checked the same as the manually controlled systems, if a method of changing the intensity is available. Intensity should be observed throughout the flight inspection.

c. Evaluation. Ensure all lamps are operating and are at the same relative intensity for each setting. If possible, the flight inspection should not be made during bright sunlight as it will reduce the effectiveness of the VGSI's. The normal intensity setting for daylight operation is 100 percent, for twilight periods 30 percent, and for hours of darkness 10 percent.

204.322 Glidepath Angle.

a. General. VGSI's provide vertical guidance for a VFR approach or for the visual portion of an instrument approach. The angle established by the VGSI's is referred to as the visual glidepath angle. The signal formats used to establish the visual glidepath angle can vary from a single light source, two or three light sources in a longitudinal array, and four or more light sources in a lateral and/or longitudinal array. Setting the required visual angle is a function of ground installation personnel.

b. Positioning.

(1) Level Run Method. This method can be used at locations where ground checkpoint distances are known. Position the aircraft inbound on the runway centerline in the below path sector at the procedural intercept altitude or 1,000 feet AGL, whichever is higher. Proceed inbound while maintaining constant airspeed and altitude.

(2) On-Path Method. Position the aircraft inbound on the runway centerline in the below path sector at the procedural intercept altitude or 1,000 feet AGL, whichever is higher. Upon reaching the glidepath indications, begin a descent and keep the aircraft in the center of the on-glidepath indication.

(3) Theodolite Positioning. Position the theodolite beside the runway so the imaginary glidepath, originating from a point abeam the runway reference point (RRP), will pass through the theodolite eyepiece. The RRP is the point on the runway where the visual glidepath intercepts the surface.

c. Evaluation.

(1) Level Run Method. The level run crossing method may be used to determine the glidepath angle of VASI's during commissioning and subsequent surveillance inspections of all systems. Position the aircraft on the final approach with the recorder running. Maintain constant airspeed and altitude while marking the recording at each checkpoint. In addition to marking the checkpoints, the flight inspector marks the below path indication, the first on-path indication, the last on-path indication, and the first indication above path. The center of the on-path indications is used for computing the glidepath angle (see Section 302 for computation of angle). If a theodolite is used, the operator tracks the aircraft during the level run. The pilot calls when passing the below path sector, the on-path indication, and the above path indication. The theodolite operator records the angle of all three call outs; the on-path angle is considered the glidepath angle. The system angle is the average of at least two level run crossings.

(2) On-Path Method. The on-path approach is used to determine the glidepath angle of VASI and PVGSI for commissioning and surveillance inspections of all systems. Most systems, such as VASI and PVGSI, should be measured at the center of the on-path indication (RED/WHITE for VASI and steady WHITE for PVGSI). AFIS or theodolite is used to determine the actual glidepath angle. If theodolite is used, the operator tracks the nose of the aircraft from the beginning of the inbound run. The pilot advises the theodolite operator when the aircraft is exactly on-glidepath. At each on-glidepath point, the theodolite operator records the vertical angle. The average of all angles recorded by the theodolite operator is the glidepath angle. The system angle is the average of at least two on-path runs.

(3) PAPI Evaluation. Determine the angle of individual light boxes by measuring the angle the light box changes color from WHITE to RED and from RED to WHITE. Fly the color changes of a single box and measure the angle at which it changes colors. The light box angle is the average of not less than two light color changes in each direction. The PAPI angle is the average between the angle of light boxes 2 and 3 of a 4-box system or light boxes 1 and 2 of a 2-box system as shown in Figure 204-H. For an accurate angle, you must average equal WHITE/RED and RED/WHITE calls; otherwise, the average is skewed in the direction of the larger number of calls. This is caused by the time delay in recognizing the color change, calling or marking the change, and recording the angle. There is no requirement to measure the angle of boxes 1 and 4 of a 4-box system unless, in the judgment of the flight inspector, the light boxes are out of symmetry with the overall system. If the symmetry is unacceptable, the angle of light boxes 1 and 4 should be measured so ground maintenance can make adjustments.

204.323 Angular Coverage.

a. General. VGSI's will provide coverage/ obstacle clearance 10^{o} either side of the runway centerline extended, measured abeam the first light bar/box. Fly a perpendicular crossing to determine the horizontal angular coverage of the VGSI's during commissioning inspections. In addition, this check is used to verify a restriction in coverage if a blanking device is used to limit coverage of a system due to obstructions or other hazardous situations.

b. Positioning. Check the angular coverage by crossing the extended runway centerline at a 90^{o} angle at a sufficient distance to enable the flight inspector to observe any shielding effect on the system. Conduct the maneuver at an altitude which provides an on-path indication.

c. Evaluation. Observe the point where the VGSI system becomes usable or unusable. The usable area is the angular coverage.

204.324 Obstruction Clearance.

a. General. The VGSI's must provide clearance above all obstacles within the commissioned operational service volume. Figures 204-D/H/J diagram the aiming of light boxes and installation obstruction clearance requirements for the different type VGSI systems. Flight inspection does not verify obstruction clearance as determined by site survey. It does verify that specific VGSI below path indications clear all obstacles within the commissioned operational service volume. The below-path approach is conducted during commissioning inspections and anytime there is a questionable obstruction to determine satisfactory guidance and obstruction clearances.

b. Positioning. Position the aircraft outside of the normal glide slope intercept distance below the glidepath. While proceeding inbound, a definite below path indication shall be visible on the VGSI's while maintaining clearance above all obstacles in the approach path. Conduct below path approaches on runway centerline extended and along each side of the angular coverage.

c. Evaluation. Obstacle clearance is checked by making approaches on runway centerline extended and along each side of the approach area from the point where the VGSI's angle intercepts 1,000 feet AGL or procedural altitude, whichever is higher. A definite climb indication must be evidenced by the system while maintaining clearance above all obstacles. If necessary, use a theodolite to verify a critical obstacle. The following climb indications must be visible while maintaining clearance above all obstacles:

(1) VASI. A definite RED/RED light must be visible on both upwind and downwind bars while maintaining clearance above all obstacles.

(2) PAPI. A definite RED must be visible on all light boxes while maintaining clearance above all obstacles.

(3) PVASI. A definite flashing RED must be visible on the light unit while maintaining clearance above all obstacles.

204.325 System Identification/Contrast.

a. General. VGSI's must provide a glidepath signal which is easily identifiable and readily distinguishable from other visual aids and aeronautical lights within the runway threshold and touchdown zone area.

b. Positioning. This evaluation is conducted during the other flight inspection maneuvers.

c. Evaluation. During the flight inspection maneuvers, observe if any surrounding lights or aircraft on taxiways interfere with the identification or use of the installed system. If there is any question of misidentification or interference, this inspection parameter should be checked at night. If a specific problem can be identified during the day, there is no requirement to confirm it at night.

204.326 Radio Control.

a. General. Commissioning flight inspection of the radio control system for VGSI's is only necessary when the VGSI's require a commissioning flight inspection in accordance with paragraph 204.31. When a commissioning flight inspection is not required, a check should be accomplished to verify system operation until a surveillance flight inspection can be performed. Prior to a commissioning/surveillance inspection, the flight inspector should consult with the appropriate personnel to determine operational procedures and correct transmitter keying sequences.

b. Positioning. The aircraft should be positioned 15 to 25 miles from the airport at minimum line-of-sight altitude.

c. Evaluation. The sensitivity of the VGSI's ground radio control should be adjusted to allow facility activation when a proper radio signal is transmitted. Verify that the VGSI's remain operational for approximately 15 minutes prior to automatic timer deactivation. Check for standardization of radio controlled lighting operations, as depicted in the Airmen's Information Manual.

204.327 Coincidence (ILS/MLS/PAR).

a. General. When VGSI's and ILS, PAR, or MLS serve the same runway, the visual approach path should coincide with the one produced electronically. Approved waivers to electronic glide slopes shall apply to VGSI systems.

(1) VASI. The two-bar VASI point of intersection of the visual glidepath angle shall be within $\pm$50 feet of the point where the projected straight line path of the precision approach glidepath intercepts the runway centerline.

(2) PAPI and PVASI. The PAPI and PVASI are placed at the same distance from the threshold as the emanating point of the electronic glide slope, with a tolerance of $\pm$30 feet. This procedure shall be modified for runways that serve aircraft in height group 4 (FAA Order 6850.2). For these runways, the distance of the PAPI or PVASI from the threshold shall equal the distance to the electronic glide slope source plus an additional 300 feet.

b. Positioning. Not applicable.

c. Evaluation. Compare the commissioned angle and runway point-of-intercept of the precision approach aid with the commissioned angle and runway point-of-intercept of the VGSI system to determine it meets all requirements of this section.

204.4 Analysis. Many factors, such as snow, dust, precipitation, color of background, terrain, etc., affect the pilot's color interpretation of the VGSI. Some deterioration of system guidance may occur as the pilot approaches the runway threshold due to the spread of light sources and narrowing of individual colors.

204.5 Tolerances. Classification of the system based on flight inspection results is the responsibility of the flight inspector. All systems shall meet these tolerances for an unrestricted classification. USAF/USN may commission facilities that do not meet the criteria for visual glidepath angle, glidepath coincidence, or RRP. VGSI system angle and the runway served are included in the routine FSS/commissioning message for appropriate publication.

a. Light intensity. All lights shall operate at the same relative intensity at each setting.

b. Visual Glidepath Angle.

(1) The visual glidepath is normally 3.0°, unless a higher angle is necessary for obstacle clearance or special operations. For nonjet runways, this may be raised to 4.0° if required to provide obstacle clearance. If used, the higher angle must be specified in a Notice to Airmen and published in the Airport Facility Directory.

(2) The effective glidepath angle shall be within 0.20° of the established or desired angle.

(3) When installed on a runway served by ILS/MLS/PAR providing a glidepath, the visual glidepath angle will be within 0.20° of the published ILS/MLS/PAR glidepath angle, and the RRP will be within ±50 feet for VASI and ±30 feet for PAPI and PVGSI of the ILS/MLS/PAR projected intercept point. For PAPI and PVGSI, this procedure is modified for runways that serve aircraft in height group 4. For these locations, the distance of the system from the threshold shall equal the distance to the electronic glide slope source plus an additional 300 feet +50 , -0 feet.

c. Angular Coverage. The VGSI's shall provide guidance relative to the approach angle over a horizontal angle of not less than 10° either side of the runway centerline extended. When coverage or obstacle clearance is less than 10° either side of runway centerline, restrict the facility, issue a NOTAM, and ensure publication in the Airport/Facility Directory.

d. Obstacle Clearance. The visual glidepath shall be at least 1.0° above all obstacles in the final approach area. A definite fly-up indication shall be visible while maintaining clearance above all obstacles within the approach area.

e. Airfield/System Contrast. The system shall provide a glidepath signal which is easily identifiable and readily distinguishable from other visual aids and aeronautical lights within the installed environment. Misidentifying or failure to readily acquire the VGSI system will require an unusable status designation.

204.6 Adjustments. See paragraph 106.35

204.7 Records, Reports, and Notice to Airmen (see Section 108).

204.71 Reports. Flight inspection report instructions are contained in FAA Order 8240.36, Instructions For Flight Inspection Reporting (latest edition). Include suitable remarks in the commissioning flight inspection report to adequately describe the facility equipment and the radio control procedure to be used. Surveillance flight inspections of the VGSI's are reported on FAA Form 8240-19, Flight Inspection Report -- Nondirectional Beacon, Direction Finding, Visual Aids, Communications, or on the primary NAVAID flight inspection report that the VGSI is associated with.

FIGURE 204-A. VASI-2

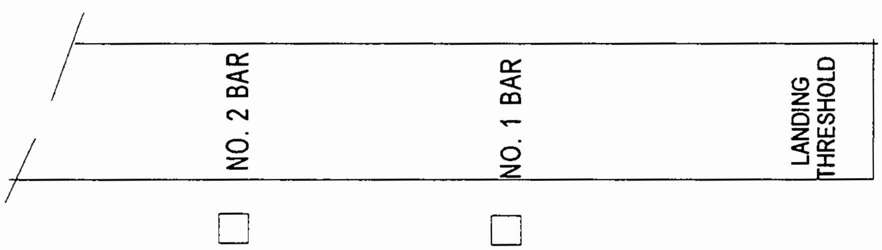


FIGURE 204-B. VASI-4 SYSTEM LAYOUT

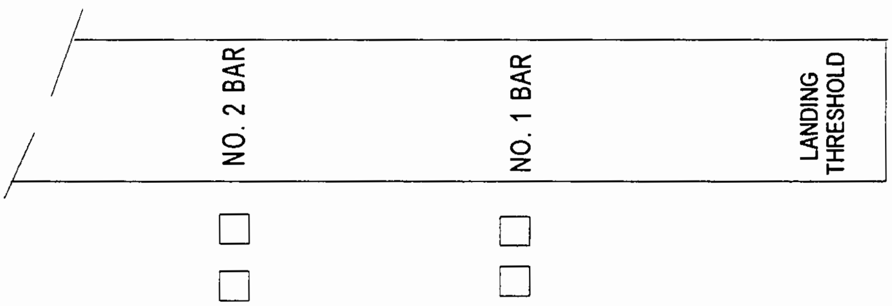
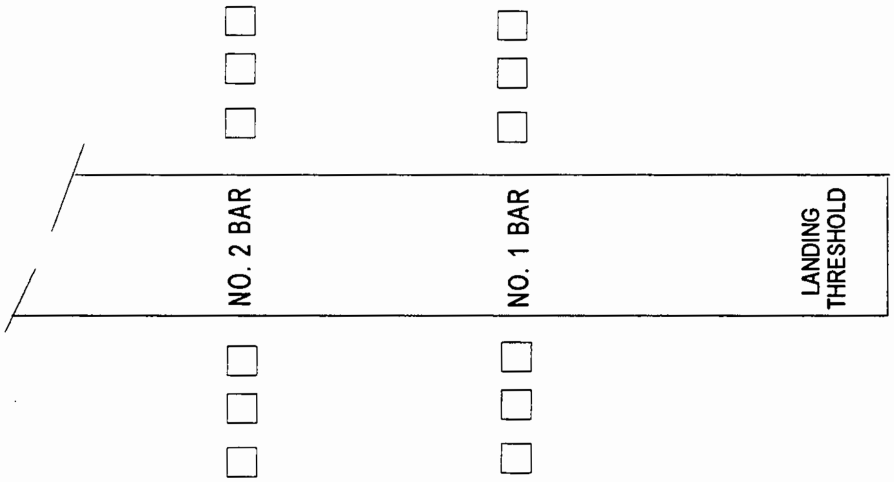


FIGURE 204-C. VASI-12 SYSTEM LAYOUT



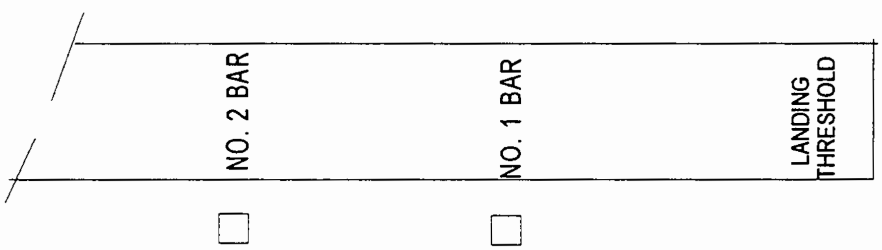


FIGURE 204-A. VASI-2

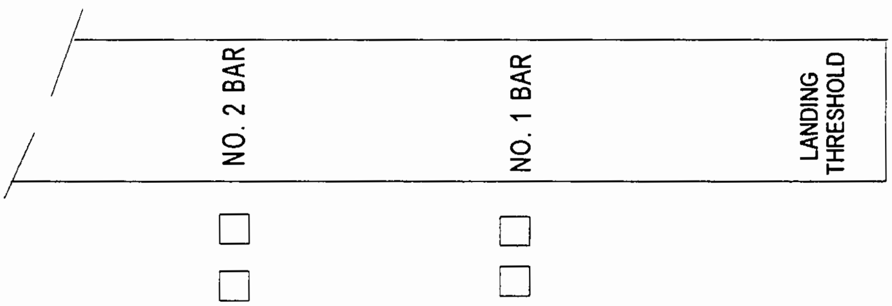


FIGURE 204-B. VASI-4 SYSTEM LAYOUT

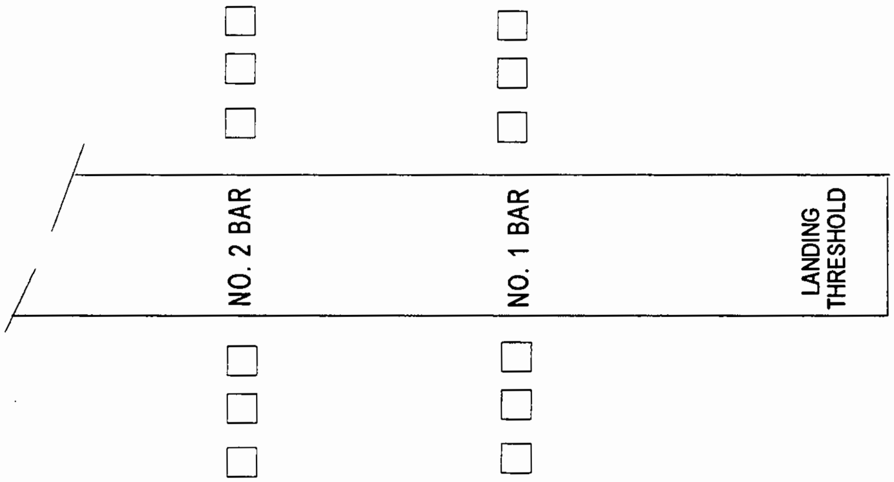


FIGURE 204-C. VASI-12 SYSTEM LAYOUT

FIGURE 204-E. SYSTEM LAYOUT, WALKER 3-BAR VASI (VASI-6)

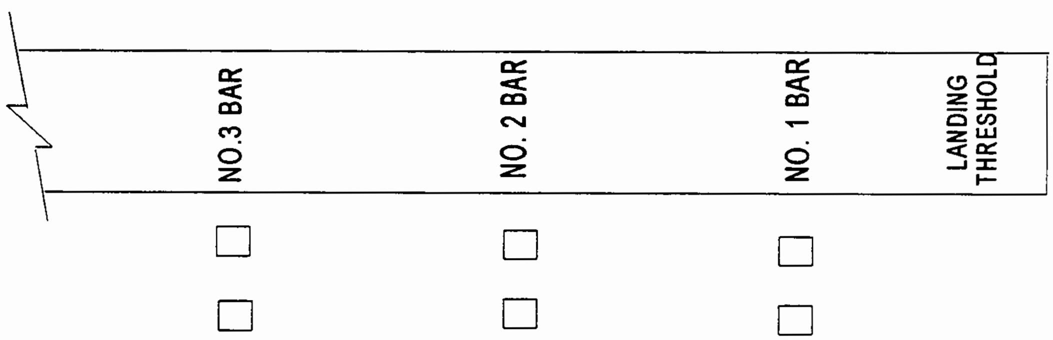


FIGURE 204-F. SYSTEM LAYOUT, WALKER 3-BAR VASI

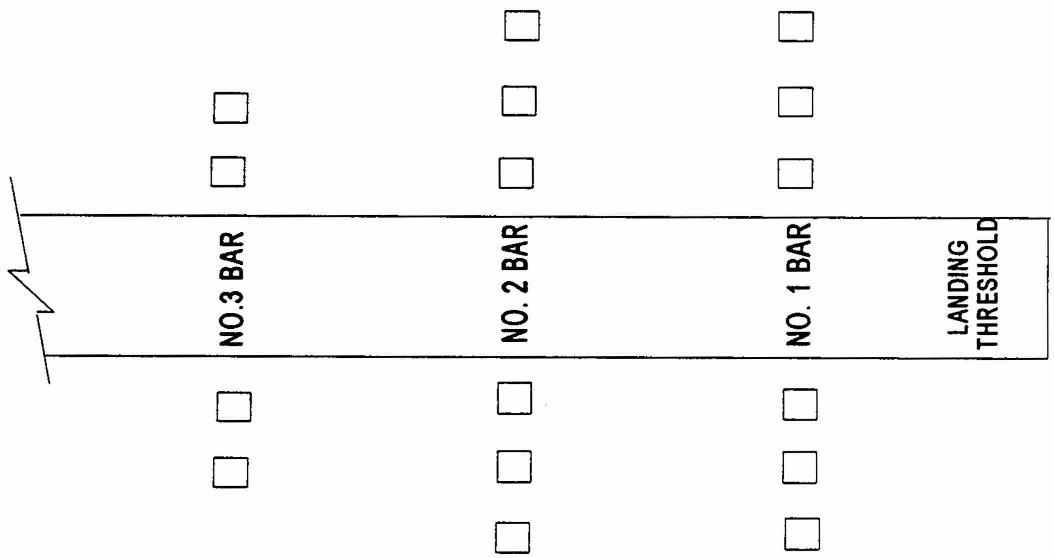


FIGURE 204-G. AIMING AND OBSTRUCTION CLEARANCE DIAGRAM FOR WALKER 3-BAR VASI

A = AIMING ANGLE, NO. 3 BAR = 3.25°

B = AIMING ANGLE, NO. 2 BAR = 3.0°

C = AIMING ANGLE, NO. 1 BAR = 2.75

T^1 = THRESHOLD CROSSING HEIGHT, LOW GLIDEPATH

T^2 = THRESHOLD CROSSING HEIGHT, HIGH GLIDEPATH

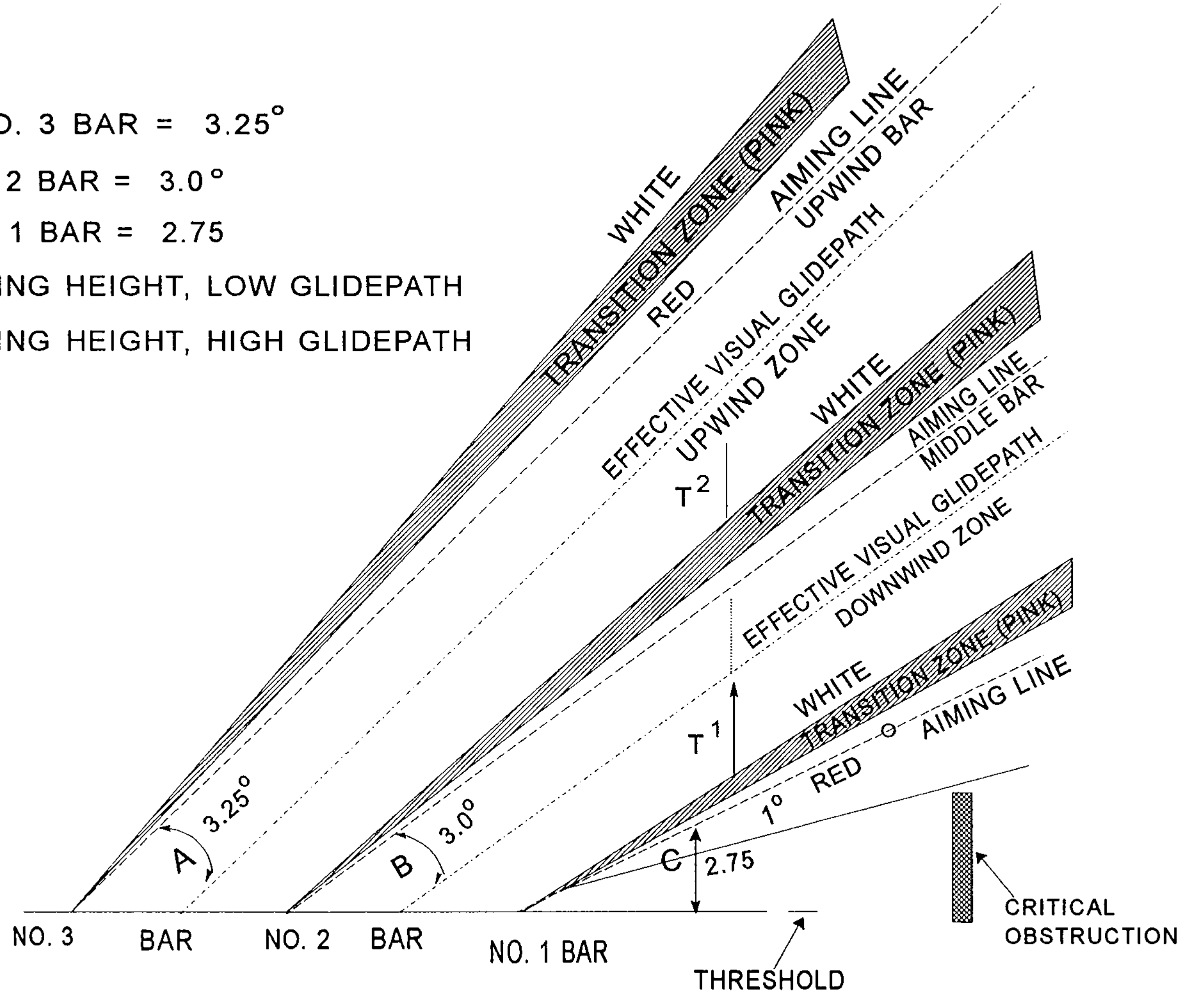


FIGURE 204-H. PAPI APPROACH PATH (SIDE VIEW)

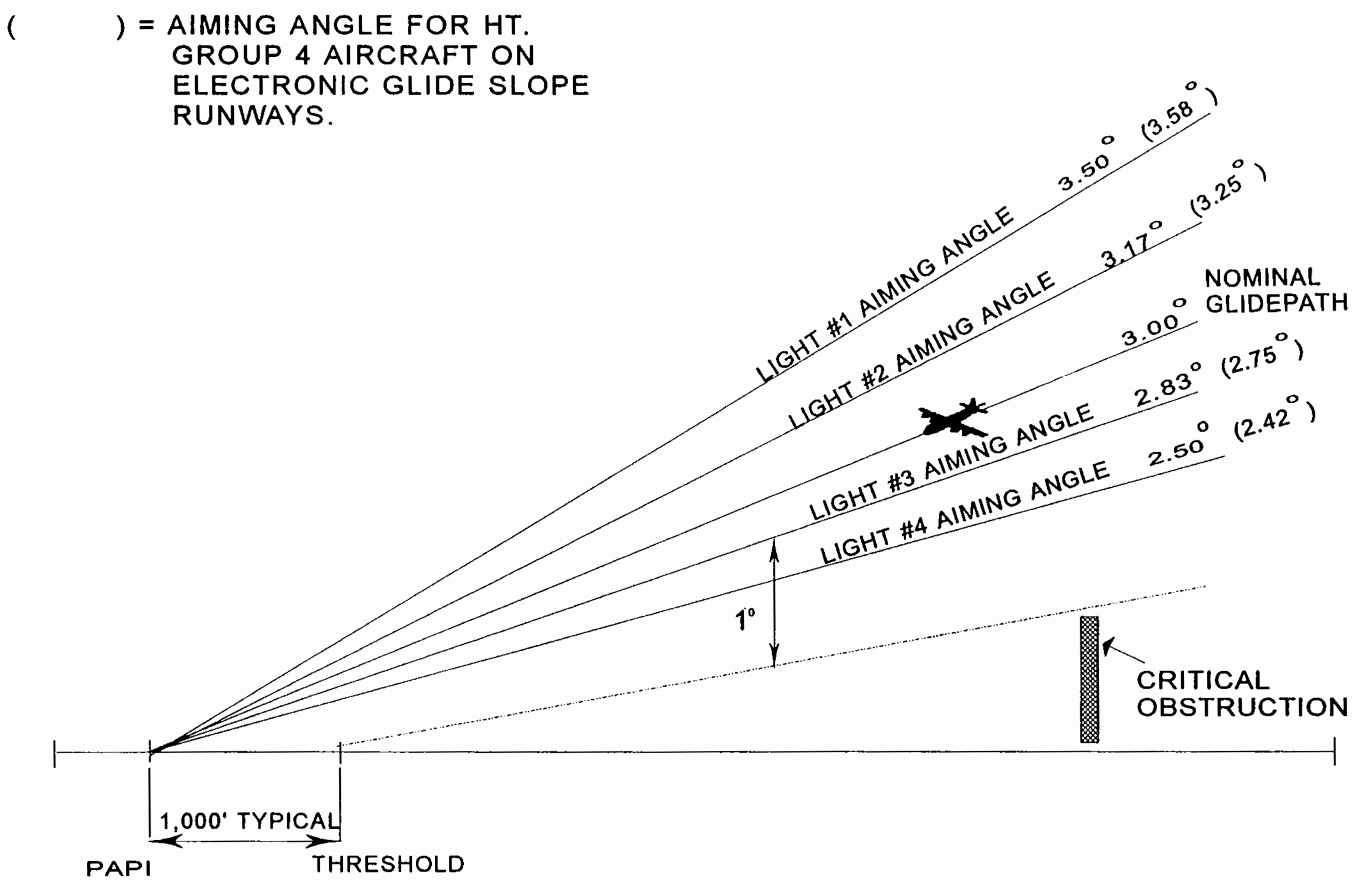


FIGURE 204-H. PAPI APPROACH PATH (SIDE VIEW)

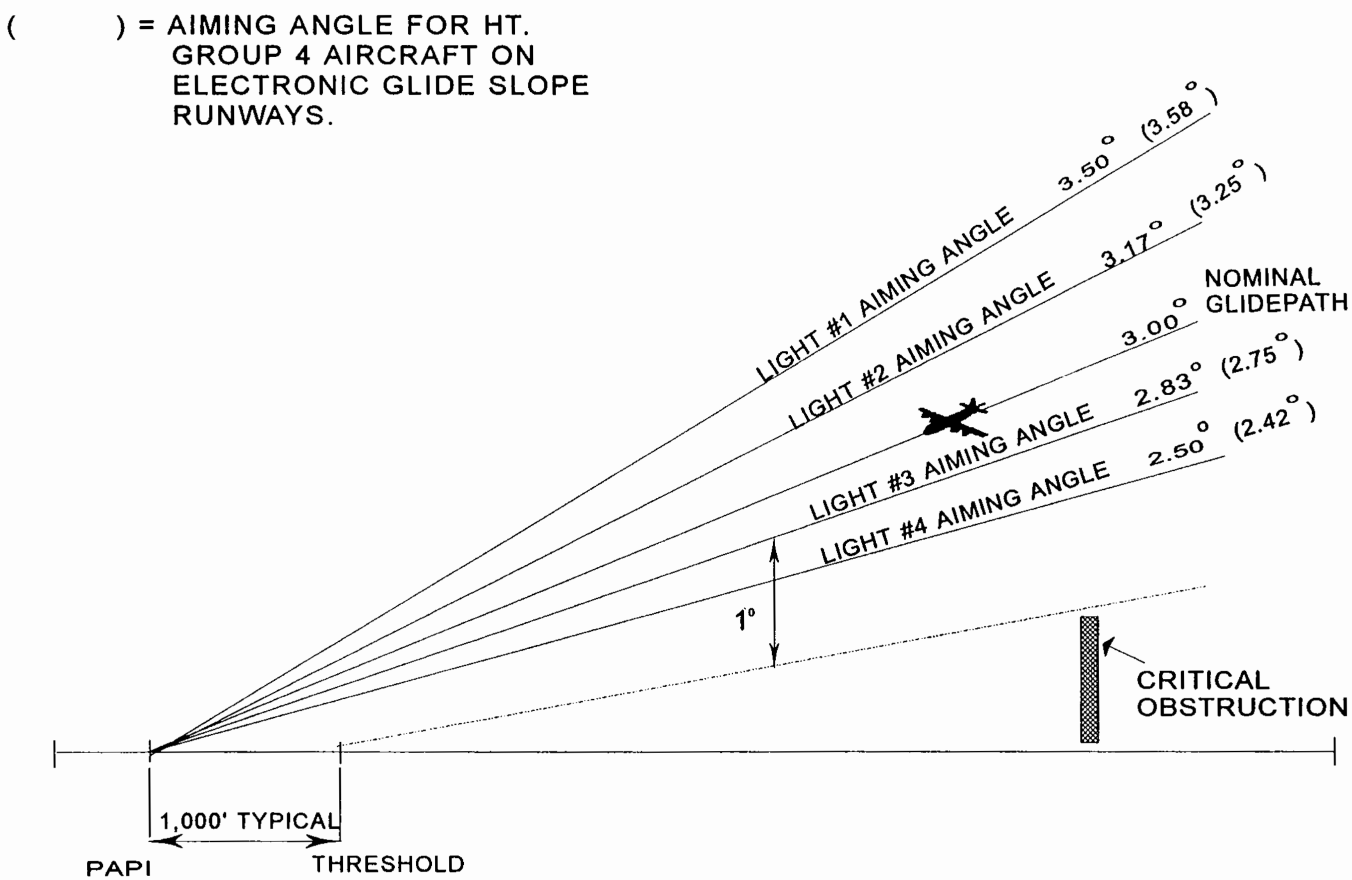
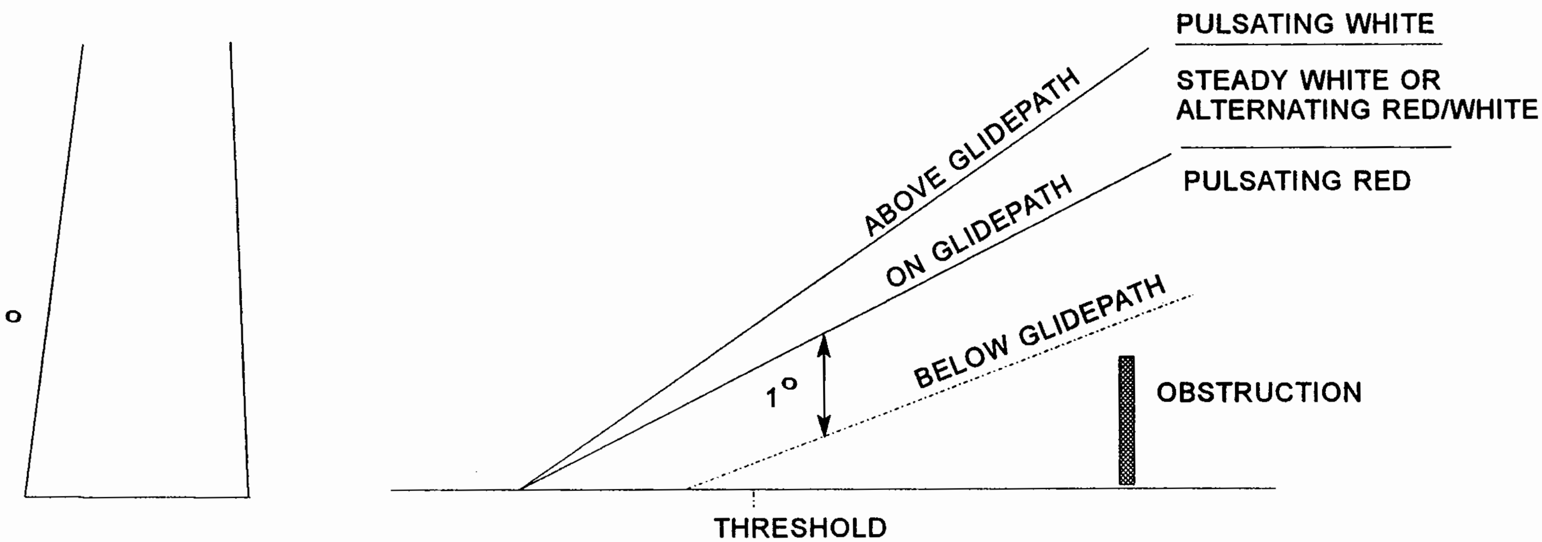


FIGURE 204-J. PVGI APPROACH PATH (SIDE VIEW)



SECTIONS 205 - 206

RESERVED

SECTIONS 205 - 206

RESERVED

SECTION 207. LOW AND MEDIUM FREQUENCY NONDIRECTIONAL BEACONS (NDB)

CROSS INDEX

SECTION 207. LOW AND MEDIUM FREQUENCY NONDIRECTIONAL BEACONS (NDB)

207.1 INTRODUCTION.

a. Low and medium frequency beacons transmit nondirectional signals on a continuous carrier keyed with either 400 or 1,020 Hz amplitude modulated Morse code identification. The carrier frequency bands are 190 to 535 kHz and 1,600 to 1,800 kHz.

b. Nondirectional Beacons are classified according to their intended use. The classifications are:

(1) Compass Locators (LOM, LMM)
(2) MH Facility
(3) H Facility
(4) HH Facility

207.2 PREFLIGHT REQUIREMENTS.

207.21 Facilities Maintenance Personnel shall prepare for the specific inspection according to the procedures outlined in Section 106.

207.22 Flight Personnel. The flight crew shall adhere to the procedures outlined in Section 106. For a commissioning inspection, the flight inspector shall prepare a chart with the facility plotted and orbit depicted.

207.3 FLIGHT INSPECTION PROCEDURES.

Flight inspection of the facility determines the facility coverage and quality of the signal. The flight inspector shall verify the accuracy of the Morse code identifier and check for interference during all inspections.

207.31 Checklist.

Type Check	Ref. Para	C	P
Identification	207.3201	X	X
Voice	207.3202	X	X
Coverage	207.3203a	X	
	207.3203b		X
Standard Instrument Approach Procedure	207.3204a	X	
	207.3204b		X
Station Passage	207.3205	X	X
Standby Transmitter	207.3206	X	X
Standby Power	207.3207	X	

207.32 Detailed Procedures.

207.3201 Identification. The flight inspector shall monitor the Identification during the evaluation for clarity and interference throughout the intended service volume.

207.3202 Voice. When installed, the voice feature enables the Nondirectional Beacon to transmit messages such as weather reports and observations. The flight inspector shall verify the ability of the appropriate ground station to control these broadcasts and to select or de-select this feature.

207.3203 Coverage.

a. Commissioning Inspections. Coverage shall be evaluated on an orbit with radius equal to the area of intended use per paragraph 207.5c(1) and with the facility radiating at the reduced RF power reference level as determined by Airway Facilities. The flight inspector shall fly the orbit at 1,500 feet above the facility elevation except where terrain, obstructions, or hazards to flight interfere. Where terrain interferes, fly the orbit at 1,000 feet above the terrain. Evaluate obstructions or hazards for impact on intended procedures and advise the Procedure Specialist. Evaluate the signal for excessive needle oscillation, weak or garbled ident, and interference throughout the entire orbit. Coverage at distances greater than the orbit radius will be certified for specific routes or transitions. The flight inspector shall fly intended routes or transitions at the minimum altitudes and maximum distances as depicted in the flight procedure document. For satisfactory performance, the facility shall meet the tolerances in paragraph 207.5. If the facility does not support the procedure, the flight inspector shall determine the minimum altitudes and maximum distances that meet all the tolerances in paragraph 207.5 and forward this information to the Procedure Specialist.

b. Periodic Inspection. Coverage will be evaluated during all inspections. The flight inspector shall use his/her discretion in the choice of procedures to verify that the facility performs satisfactorily to the limits of its intended use. Routes or transitions that exceed the usable distances in paragraph 207.5c(1) shall be evaluated to ensure continued support of the procedure. The flight inspector shall evaluate the signal for needle oscillation, weak or distorted identification, and interference.

207.3204 Standard Instrument Approach Procedure (SIAP).

a. Commissioning Inspection of SIAP. The flight inspector shall check all proposed instrument procedures to ensure compliance with tolerances in paragraph 207.5. The flight inspector shall follow the procedures for inspection of SIAP's contained in chapter 214 of this manual. The flight inspector shall make every effort to fly the procedure as the Procedure Specialist depicted, noting human factor elements and flyability. The flight inspector has the discretion to reject the procedure if in his/her opinion it does not constitute a satisfactory maneuver from a pilot or human factors vantage. The flight inspector shall make recommendations to the Procedure Specialist to correct for flyability and human factors noted during the initial inspection. For a commissioning flight inspection, the flight inspector shall ensure the facility complies with the tolerance of 207.5b and shall note the maximum distance that voice can be recognized as a baseline for future inspections.

b. Periodic Inspections. The flight inspector shall evaluate the final and missed approach segments of each SIAP based on the facility during every periodic inspection. The flight inspector shall evaluate transitions that originate outside of normal facility coverage per paragraph 207.3203b from the point of origination.

207.3205 Station Passage. Evaluate the area over the facility for correct indication of station passage. Needle reversal should occur when the aircraft passes directly over or in very near proximity to the station. If an indication of false station passage occurs during any evaluation, the facility shall be NOTAMed out of service and the cause investigated. Momentary needle hunting while over the station will not be construed as false passage.

207.3206 Expanded Service Volume (ESV's) on commissioned facilities may be established at normal power.

207.3207 Standby Equipment. At facilities where dual transmitters are installed, the flight inspector shall check each for a commissioning inspection. The flight inspector shall also verify that the control station has transmitter selection capability. The flight inspector shall alternate between transmitters during successive periodic inspections and verify the correct transmitting equipment is in operation prior to initiating the inspection.

207.3208 Standby Power. Refer to paragraph 106.43.

207.4 ANALYSIS.

a. Primary Means of Evaluation. The stability of bearing indications and the facility coded identification are the primary means of evaluating the Nondirectional Beacon.

b. Incorrect Bearing Indications. Erroneous bearing indications may have various causes, including weather phenomena, terrain, and radio interference. Analysis should encompass identification of anomaly cause when possible.

c. Application of Tolerances. The tolerances in this section are based on average atmospheric conditions. The flight inspector is expected to use good judgment in differentiating between facility performance and unusual atmospheric phenomena. To establish good facility performance baselines, commissioning flight inspections should be conducted in weather conditions that will not derogate or enhance facility performance.

207.5 TOLERANCES. Nondirectional Beacons that meet tolerances throughout the area of intended use are classified as UNRESTRICTED. Facilities that do not support routes or transitions outside of coverage as listed in paragraph 207.5c(1) will not be restricted, but use of the facility for that purpose will be denied.

a. Morse Code Identification. All facilities shall have a Morse code identifier that is correct, clear, and identifiable throughout the area of intended use, including any route or transition that may extend beyond the normal service volume. If the Morse identifier is augmented with voice identification, the voice shall adhere to the same tolerance as the associated Morse identifier.

b. Voice Transmission. Broadcast information shall be clear and recognizable for a minimum of two-thirds of the Nondirectional Beacon's usable distance.

c. Usable Distance.

(1) The minimum usable distance shall be:

(a) Compass Locator	15 NM
(b) MH Facility	25 NM
(c) H Facility	50 NM
(d) HH Facility	75 NM

(2) Maximum bearing deviation:

20 degrees (± 10 degrees).

d. NDB Approach. Bearing indicator deviation in the final approach segment shall not exceed:

10 degrees (± 5 degrees)

e. Bearing Tolerance Deviation. Short duration, out-of-tolerance needle activity (including repetitive events) will be allowed when either:

(1) the duration does not exceed four seconds on an approach (flown at a nominal 130 knot ground speed), or

(2) the duration does not exceed eight seconds for en route use;

but only if the out-of-tolerance activity cannot be construed as a station passage, and the activity is not generally one-sided when repetitive.

f. Station Passage. Station passage indications shall occur over the ground facility.

g. Standby Equipment. If installed, standby equipment shall perform to all tolerances in this section.

h. Standby Power. If installed, standby power shall cause no difference in facility performance.

207.6 ADJUSTMENTS. Requests for adjustment shall be specific. The flight inspection crew will furnish sufficient information to enable maintenance personnel to make adjustments. Adjustments which affect facility performance shall be rechecked by flight inspection.

207.7 RECORDS AND REPORTS. Records and reports are to be completed per Section 108 of this manual and appropriate sections of FAA Order 8240.36, Instructions for Flight Inspection Reporting (latest revision).

207.71 NOTICES TO AIRMEN. Notices to Airmen will be issued when necessary, per Section 107 of this manual.

b. Voice Transmission. Broadcast information shall be clear and recognizable for a minimum of two-thirds of the Nondirectional Beacon's usable distance.

c. Usable Distance.

(1) The minimum usable distance shall be:

(a) Compass Locator	15 NM
(b) MH Facility	25 NM
(c) H Facility	50 NM
(d) HH Facility	75 NM

(2) Maximum bearing deviation:

20 degrees (± 10 degrees).

d. NDB Approach. Bearing indicator deviation in the final approach segment shall not exceed:

10 degrees (± 5 degrees)

e. Bearing Tolerance Deviation. Short duration, out-of-tolerance needle activity (including repetitive events) will be allowed when either:

(1) the duration does not exceed four seconds on an approach (flown at a nominal 130 knot ground speed), or

(2) the duration does not exceed eight seconds for en route use;

but only if the out-of-tolerance activity cannot be construed as a station passage, and the activity is not generally one-sided when repetitive.

f. Station Passage. Station passage indications shall occur over the ground facility.

g. Standby Equipment. If installed, standby equipment shall perform to all tolerances in this section.

h. Standby Power. If installed, standby power shall cause no difference in facility performance.

207.6 ADJUSTMENTS. Requests for adjustment shall be specific. The flight inspection crew will furnish sufficient information to enable maintenance personnel to make adjustments. Adjustments which affect facility performance shall be rechecked by flight inspection.

207.7 RECORDS AND REPORTS. Records and reports are to be completed per Section 108 of this manual and appropriate sections of FAA Order 8240.36, Instructions for Flight Inspection Reporting (latest revision).

207.71 NOTICES TO AIRMEN. Notices to Airmen will be issued when necessary, per Section 107 of this manual.

SECTION 208. UHF HOMING BEACONS

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SECTION 208. UHF HOMING BEACONS

208.1 Introduction

a. The UHF Homing Beacon (AN/URN-12) ground station transmits a continuous carrier in the frequency range of 275 to 287 megacycles, modulated with a 1,020-cycle tone for identification purposes. The power output is approximately 15 watts.

b. The pilot of an aircraft equipped with the AN/ARA-25 or similar equipment can determine the relative bearing of, and "home" on, the facilities maintenance equipment. The airborne equipment extracts the information from signals received by the AN/ARC-27 or similar UHF communications receiver. The relative bearing of the signal source is indicated on a course indicator. Best results are obtained under straight and level flight conditions.

208.2 Preflight Requirements

208.21 Facilities maintenance personnel should prepare for flight inspection in accordance with procedures outlined in Section 106.21.

208.22 Air. The flight inspector will prepare for the flight inspection in accordance with procedures outlined in Section 106.22. In addition to the above preparations, the flight inspector will:

a. Be sure that an approved type of airborne equipment is installed and has been calibrated and aligned in accordance with current FAA directives.

b. On a suitable type of chart, scale 1:500,000 or greater, plot the exact location of the facility. Plot a series of check points spaced approximately 45° apart at a radius between 20 and 30 miles from the station. Determine the primary air routes that are served by the facility and plot the routes on the chart. Select two courses for a long-distance check. Note: These two courses may be extensions of the primary air routes previously selected, but should be at least 45° apart.

208.3 Flight Inspection Procedures. Nautical miles are used throughout this section. The primary object of the flight inspection is to determine the coverage and quality of the transmitted signal; therefore, it is necessary that the aircraft be flown through normal usage patterns and procedures to determine the usability of the facility and to ensure that the homing beacon meets the operational requirements for which it was installed.

208.31 Checklists. The following checks will be performed on all flight inspections:

- **a. Station identification**
- **b. Bearing accuracy**
- **c. Voice**
- **d. Coverage**
- **e. Low approach**
- **f. Station passage**
- **g. Standby equipment**
- **h. Standby power (See Section 106.43)**

208.32 Detailed Procedures.

208.3201 Station Identification. Select the proper frequency and check for correct identification and tone of the signal. Any discrepancies noted should be reported to maintenance personnel for corrective action before continuing the flight inspection. Note any frequency interference from other stations.

208.3202. Bearing Accuracy. Fly either inbound or outbound over the check points selected in accordance with Section 208.22 and along the primary air routes served by the facility. Fly at minimum instrument altitudes or at an altitude to ensure adequate signal strength. Check the accuracy of the bearing obtained from the airborne receiver against the values obtained from the aeronautical chart.

208.3203 Voice. If the facility is equipped with voice feature, this feature should be checked at maximum usable distance. It will be noted that most types of airborne equipment will require the receiver function selector to be placed in the RECEIVE position to receive voice transmissions. Request a long voice transmission and note the voice quality, modulation, and freedom from interference. In the event voice transmissions do not reach the maximum usable range, return inbound until they can be received satisfactorily. Record this distance on the flight inspection report.

208.3204 Coverage

a. Proceed outbound along one of the primary air routes at minimum instrument altitude until reaching 45 miles or until the pilot's directional indicator needle oscillation exceeds $\pm 5^{o}$, an excessive bearing error is encountered, or where the signal strength falls below that specified in Section 208.5(4). (See Section 208.4). The position at which any of these conditions are noted will be the usable distance. Upon completion of the investigation of the first route, proceed to the remaining routes and repeat the above procedures.

b. During the check, observe the surrounding terrain and note the location of terrain, or other obstructions that may prevent line-of-sight transmissions to an area beyond the obstructions. Reflections of radio signals, or shadow effect, caused by the intervening terrain, or other obstacles, may result in bearing errors or loss of usable signal.

c. If areas of weak signal are encountered or if terrain obstructions exist, investigate the areas in question and record the areas checked, location of apparent obstructions, and the minimum altitude and distance at which a usable signal can be received.

d. On the commissioning inspection and every second periodic inspection, proceed outbound along one of the air routes or courses selected to a distance of 100 miles at an altitude of 10,000 feet. Observe and record the extent of the pilot's direction indicator needle oscillation, AGC, and the station identification. Then proceed to the other air route or selected course at the 100-mile range and fly inbound along this route to the facility site, again noting the identification, AGC, and needle oscillation.

208.3205 Low Approach. If this facility is to be used as a low approach aid, a low approach will be made for each of the proposed or approved procedures. Check each approach procedure for flyability. Unusual conditions noted will be further investigated.

208.3206 Station Passage. Fly over the antenna site and note the position where station passage is indicated. The station passage should be indicated by a sharp positive reversal of the pilot's direction indicator needle. No specific tolerances are established for station passage; however, it should be encountered approximately over the facility. Any area where the needle has a tendency to reverse itself before actually passing over the station should be plotted on the chart and reported on the flight inspection report.

208.3207 Standby Equipment. Standby equipment will be spot-checked to ascertain that it meets the same tolerances as the primary equipment.

208.3208 Standby Power. See paragraph 106.43.

208.4 Analysis

a. From the data obtained during the flight inspection, the flight inspector must determine if there are any areas where the facility fails to meet the coverage and/or bearing tolerance. If such areas were noted during the flight inspection, he should analyze all data to determine if such effects are caused by terrain or equipment. Normally this facility cannot be expected to give reliable information at ranges and altitudes which are below line of sight.

b. The airborne ADF equipment (AN/ARA-25) is an attachment applied to the IHF transceiver to enable it to take bearings on a transmitted signal. While in the ADF position, the ADF antenna seeks a null in the process of presenting a bearing. Under these conditions, very little signal from the transmitter is applied to the IHF transceiver, and tone identification cannot be heard at distances greater than 70 miles, line of sight, but may be heard at shorter distances depending upon the ambient electrical noise level of the airborne ADF system. (The antenna drive mechanism develops a 100-cycle signal that is great enough to blanket the tone identification except at close range to the transmitter.) Continuous switching from the RECEIVE to ADF position must be accomplished in order to monitor both the identification and the ADF indications.

c. The bearing indicator normally hunts plus or minus a few degrees of the received bearing when the transmitter is operating satisfactorily. In the absence of a carrier, the bearing indicator usually rotates slowly and continuously over 360^{o} of azimuth, or remains stationary. For this reason, the station must be monitored intermittently in the RECEIVE and ADF position.

208.5 Tolerances. All UHF Homers will meet these tolerances for an UNRESTRICTED classification. Classification of the facility based on flight inspection results is the responsibility of the flight inspector.

a. Identification. Station Identification will be correct, clear, and intelligible.

b. Bearing Error. The maximum bearing error will not exceed $\pm 5^{\circ}$.

c. Voice. If provided, will be clear and readable at distances equal to or greater than two-thirds of the maximum usable distance of the facility.

d. Coverage. Usable distance will not be less than 45 miles at minimum instrument altitude. Coverage is based on the following criteria:

(1) ADF needle oscillation will not exceed $\pm 5^{\circ}$.

(2) Maximum bearing error will not exceed $\pm 5^{\circ}$.

(3) Signal strength of 10*uv* or more as indicated by receiver AGC with the receiver function selector in the RECEIVE position.

Coverage limits may be determined by any one or a combination of the above factors.

e. Low Approach. Each approach procedure shall be flyable from a user standpoint.

f. Station Passage. At all altitudes, the needle reversal shall occur approximately over the ground facility. (Any condition of false reversal attributable to the ground facility shall require a notice to airmen.)

g. Standby Equipment. Standby equipment will meet the same tolerances as specified for the primary equipment.

h. Standby Power. Standby power, if installed, will cause no change in station performance.

208.6 Adjustments. (See Section 106.35)

208.7 Records, Reports, and Notices to Airmen. (See Section 108.)

SECTION 209. LORAN C

209.1 INTRODUCTION.

a. Loran C is a low frequency radio navigational aid operating in the radio frequency spectrum of 90 to 110 kHz. The United States Coast Guard operates the U.S. station transmitters. The transmitting system is essentially a closed loop and self-monitoring one that prevents any control of adjustments by FAA personnel. Therefore, the flight inspections referred to in this chapter are standard instrument approach procedures (SIAP).

b. All Loran C signals are modulated and pulsed with unique synchronizing pulses, repetition rates and phasing codes centered about 100 kHz. Using this information, a receiver identifies individual transmitters. The receiver measures the time interval between the reception of specific transmitter signals and calculates position coordinates and course guidance information.

c. Loran C signals are used for en route and terminal navigation. Specific CHAIN and TRIAD stations must be used and certified for instrument approach procedures by flight inspection. These same stations must be monitored by a local area monitor. This monitor records timing information that determines receiver time difference calibration values. These calibration values are necessary to ensure repeatable approach accuracies during all seasons.

209.2 PREFLIGHT REQUIREMENTS.

209.21 Facilities Maintenance Personnel. Conduct an LSES evaluation of the Loran C signals at the approach site before the commissioning flight inspection. This evaluation will establish the TD correlation between the LAM and the site. Any abnormal signals or out-of-tolerance conditions observed on the LSES disqualifies the approach site.

209.22 Flight Personnel. In addition to the applicable preparations in paragraph 106.3, the flight inspector prepares charts, obtains receiver TD cali-bration values, and approach waypoint information. Review the GDOP, predicted SNR values, and LSES evaluations. Coordination between the AVN Data Analysis Branch and the flight inspector is essential.

209.3 FLIGHT INSPECTION PROCEDURES. Use the CHAIN and dedicated TRIAD stations on the approach procedure. When marginal or out-of-tolerance conditions are discovered, the use of other stations may be investigated. Cycle slip disqualifies a procedure (see paragraph 209.42).

209.31 Checklist.

Type Check	Reference Paragraph	C	P
Transition/Feeder Route Segment	209.321	X	
Initial/Intermediate Approach Segment	209.322	X	
Final Approach Segment	209.323	X	X
Missed Approach Segment	209.324	X	
Bracketing Segment	209.325	X	

209.32 Detailed Procedures. Flight inspection of Loran C approaches and the supporting signals is conducted using tracks between waypoints. The following actions are required during the approach evaluations:

a. Select the correct CHAIN and dedicated TRIAD stations.

b. Use the procedural waypoint coordinates.

c. Use the published TD calibration values.

d. Select the approach mode while flying the track maneuvers.

e. Monitor signals throughout the approach. Record position coordinates and signal parameters at each waypoint and whenever tolerances are exceeded.

f. Record XTK and AFIS information during all maneuvers.

209.321 ***Transition/Feeder Route Segment.***

a. This segment provides a transition route from a navigational aid or fix to the IAF.

b. Segments may be flown in either direction between the feeder fix and the IAF.

c. Evaluate for cycle slip and SNR. Record XTK (and all error traces when using AFIS) during the entire segment. Record the position coordinates at each waypoint and evaluate for accuracy when using AFIS.

209.322 Initial/Intermediate Approach Segments.

a. These segments provide a transition route from the IAF and IF to the FAF.

b. Segments may be flown in either direction between the IAF and the FAF.

c. Evaluate for cycle slip and SNR. Record XTK (and all error traces when using AFIS) during the entire segment. Record the position coordinates at each waypoint and evaluate for accuracy when using AFIS. Verify controlling obstructions.

209.323 Final Approach Segment.

a. This segment is the route from the FAF to the MAP.

b. This segment shall be flown from the FAF to 100 feet below the minimum descent altitude. Check the accuracy of the MAP or AER on the ground.

c. Prior to the MAP, visually confirm that the course between the two waypoints coincides with the intended final approach course. Evaluate for cycle slip and SNR. Record XTK (and all error traces when using AFIS) during the entire segment. Evaluate the MAP waypoint for accuracy. When the MAP waypoint occurs at a point other than the AER, the AER may be used for the accuracy check. Airborne evaluations are acceptable. During this segment, interference is more likely to be encountered. Evaluate suspected electromagnetic interference with the spectrum analyzer. Verify the controlling obstructions.

209.324 Missed Approach Segment.

a. This segment provides a transition route from the MAP to a waypoint for another approach or to join the en route structure.

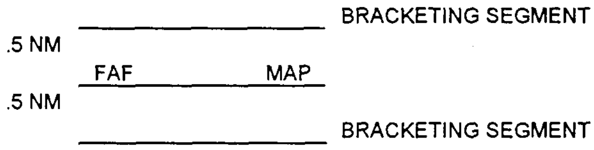
b. The missed approach procedure is flown from the MAP.

c. Evaluate for cycle slip and SNR. Record XTK (and all error traces when using AFIS) during the entire segment. Record position coordinates at each waypoint and evaluate for accuracy when using AFIS. Verify the controlling obstructions.

209.325 Bracketing Segment.

a. The inspection ensures usable signals are available .5 NM each side of the final approach course.

b. Segments shall be flown in either direction between the FAF and the MAP at 100 feet below the minimum descent altitude.



c. Evaluate for cycle slip and SNR. Record XTK (and all error traces when using AFIS) during the entire segment.

209.4 ANALYSIS.

209.41 Course Structure.

a. Description. Course structure is the excursion characteristics of the Loran C receiver crosspointer which includes bends, roughness, and other aberrations. The computed course information shall not exhibit irregular or erratic course structure. Excursions of the course are caused by errors in the transmitted signal, avionics equipment, and in areas having poor GDOP.

b. Analyzation.

(1) Analyze real time XTK error trace for excursions from zero reference line. Deviations exceeding 0.3 NM should be evaluated. This evaluation should be similar to the procedure described in paragraph 209.323c.

(2) Analyze corrected error trace for position accuracy.

209.42 Cycle Slip.

a. Description. Normally a receiver will track the third cycle of the pulsed 100 kHz carrier for time measurements. When cycle slip occurs, the receiver tracks the wrong cycle. Each cycle slip results in a 10-microsecond error and a corresponding error in navigation accuracy. Cycle slip can be caused by large ECD, low SNR values, RF interference, and unusual RF signal propagation. Cycle slip is more likely to occur when a receiver first acquires a new combination of signals.

b. Envelope to Cycle Discrepancy (ECD). ECD is the difference between the desired and actual zero phase crossing of the third cycle. It is affected by RF signal propagation, SNR, interference, etc. ECD values exceeding -2.4 to +3.5 microseconds may cause cycle slip. When ECD values exceed the range of -2.4 to +3.5 microseconds, ensure the position accuracy and course structure meet tolerances.

c. Analyzation. Compare the received latitude and longitude positions to a known geographic position or use an AFIS. A difference greater than 1.0 NM may indicate cycle slip. A receiver flag alarm may indicate cycle slip. If cycle slip occurs, the SIAP shall be disapproved.

209.43 Electromagnetic Spectrum.

a. Description. The RF spectrum from 90 to 110 kHz should be observed for RF interference. Interfering signals shall not affect accuracy. Electrical power lines, factories, and RF transmitters are potential sources of interference. Electrical power lines (with RF signals), within ± 1,200 feet of the final approach segment, may affect receiver performance.

b. Analyzation. If interference is suspected, use the spectrum analyzer to identify the source. If unable to eliminate interference, disapprove the procedure.

209.44 Position Accuracy.

a. Description. The position accuracy is the difference between the receiver position (using TD calibration values) and the correct geographic position. System accuracies are improved by seasonal receiver TD calibration values.

b. Analyzation. Verify the correct CHAIN, dedicated TRIAD, and TD calibration values are inserted in the receiver. Analyze position accuracy by using the AFIS or visual checkpoints.

209.45 Signal-to-Noise Ratio (SNR).

a. Description. SNR is a ratio of signal strength versus receiver noise. It may affect position accuracy. Loran C signals may be affected by atmospheric noise, aircraft static charges, power line signals, etc. Low values may cause cycle slip. Two methods of measuring receiver SNRs are SNR-FS and SNR-PH.

b. Analyzation. Monitor and record all SNR values. CALIBRATED SNR values should be used.

209.5 TOLERANCES. During approach evaluations, the signals shall meet the following tolerances:

Parameter	Reference Paragraph	Tolerance/Limit
Course Structure	209.41	Within ± 0.3 NM of the desired track during all approach segments.
Cycle Slip	209.42	None allowed
Electromagnetic Spectrum	209.43	Interference shall not affect receiver performance or accuracy
Position Accuracy	209.44	Within ± 0.3 NM
Signal-to-Noise Ratio	209.45	+3 dB or greater

209.6 ADJUSTMENTS. Reserved.

209.7 RECORDS, REPORTS, AND NOTICES TO AIRMEN. (See Section 107 or 108.)

SECTION 210. FLIGHT MANAGEMENT SYSTEM (FMS) PROCEDURES

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SECTION 210. FLIGHT MANAGEMENT SYSTEM PROCEDURES

210.1 INTRODUCTION. This section outlines procedures for the flight inspection of instrument flight procedures which use FMS multisensor non-VOR/DME Area Navigation Equipment (RNAV) for primary navigation guidance.

a. System Description. Multisensor non-VOR/DME RNAV equipment determines aircraft position by processing data from various input sensors. Aircraft position may be fixed by various methods depending on factors such as availability of sensors, signal parameters, location and/or flight phase. Unlike early RNAV systems which used only VOR/DME rho-theta for position fixing, multisensor navigation systems employ a variety of sensors such as: distance measurements from two or more DME ground stations (DME/DME), VOR/DME, inertial reference unit (IRU), Omega/VLF, Loran-C, and satellite (GPS). These various sensors may be used by the navigation computer individually or combined in various ways (based on internal programming) to derive aircraft position. Navigation values such as distance and bearing to a waypoint (WP) are computed from the derived aircraft latitude/longitude and the coordinates of the waypoint. Course guidance is generally provided as a linear deviation from the desired track of a great circle course. The desired course may be pilot selectable (e.g., pseudo course or go direct) or may be determined automatically by the navigation computer based on the locations of successive waypoints (point to point).

b. Certification to Fly FMS Procedures. The criteria for /F designation is only for certain Flight Management System (FMS) and Electronic Flight Instrument System (EFIS) /E equipped air carrier aircraft and specially qualitifed crews.

c. Flight Inspection of FMS Procedures. The flight inspection of FMS procedures will evaluate the soundness of the procedure in accordance with Section 214 and identify any deficiencies in the procedure by emulating the flight of a "/F" aircraft to the extent possible. (Emulation of the procedure is required, as assigned flight inspection aircraft are not equipped or authorized to perform FMS operations under "/F".) FMS procedures will overlie existing procedures to the maximum extent possible. A special flight inspection of an "overlay" FMS procedure is not normally required. If any doubt exists as to the soundness of an FMS procedure, a flight inspection will be performed. Stand-alone FMS procedures require a commissioning flight inspection.

210.2 PREFLIGHT REQUIREMENTS. Prepare for flight inspection in accordance with paragraph 106.32.

a. Aircraft Requirements. In order to emulate "/F" aircraft flying FMS procedures, the flight inspection aircraft used shall be equipped with an operating RNAV or FMS system with Inertial Reference Unit (IRU) inputs as a minimum, an EFIS system, and an autopilot. If any part of the FMS procedure cannot be adequately emulated with the flight inspection aircraft, further evaluation may be required by a Flight Inspector acting as an observer on board a "/F" aircraft flying the procedure.

b. Procedural Review. FMS Procedures shall carry the remark "FOR USE BY SLANT FOXTROT (/F) AIRCRAFT ONLY". The Flight Inspector shall review the procedure as forwarded by the Procedure Specialist in accordance with this Section and the requirements of Section 214. The FAA 8260 Forms appropriate for the procedure being evaluated shall be reviewed and aboard the aircraft during the inspection.

210.3 FLIGHT INSPECTION PROCEDURES

a. General

(1) During flight, the RNAV/FMS system shall be using IRU inputs as a minimum. If the inspection is being conducted in a "/F" aircraft, all Airplane Flight Manual (AFM) conditions and limitations pertaining to "/F" operations shall be observed.

(2) The aircraft should be flown with the autopilot coupled to the RNAV/FMS system.

(3) Verify all course and distance information provided by the RNAV system agrees with the procedural information/charts for the procedure. The FMS procedure course must be displayed on the EFIS during the inspection. The procedure depicted on the EFIS shall agree with the charted portrayal.

(4) Verify any designated runway update reference points which are to be used by an aircraft prior to initiating an FMS SID. Perform an IRU down mode alignment or fix update at a known geographical point prior to takeoff.

(5) Monitor any announced "quality factors" of the navigation system sensors throughout the procedure. Note any degradation of system position accuracy which may affect the track flown.

(6) Verify that a current navigation data base and program revision, as appropriate, are installed.

(7) If the FMS procedure overlies an existing procedure, simultaneously monitor and compare the navigation guidance for the existing procedure with the RNAV/FMS navigation guidance. Note any discrepancies between the procedures.

b. Waypoints.

(1) The Flight Inspector shall verify that the procedure waypoints are loaded into the RNAV/FMS flight plan in the sequence depicted by the procedure. If the navigation system used has the capability of selecting fly-over (FOWP) or fly-by (FBWP) waypoint crossing modes, verify that each waypoint is correctly loaded by its type (FOWP or FBWP), as specified by the procedure. (Note: a FOWP is overflown before commencing a turn; a FBWP is not necessarily overflown due to automatic turn anticipation based on groundspeed and navigation computer algorithms.)

(2) If the navigation system used has the capability of automatically loading the procedure from a data base into the flight plan, or if a "/F" aircraft is used, the waypoints describing the FMS procedure shall be automatically loaded into the FMS flight plan from the FMS data base, in the sequence they are to be flown. In this case, manual input is not acceptable.

c. Airspeed, Altitude, and Track.

(1) If more than one airspeed is depicted for the procedure, the Flight Inspector shall determine which airspeed will be utilized for the inspection. Multiple runs at various airspeeds may be required if the Flight Inspector, the Procedure Specialist, or Air Traffic Control (ATC) deem it necessary.

(2) Fly the FMS procedure at the minimum altitudes specified.

(3) The automatic leg change mode shall be used for the procedure.

(4) An FMS SID procedure may be flown from an actual takeoff or from a low approach. If the low approach method is used, cross the runway threshold at 50 feet and verify navigation system accuracy by performing a fix update over the threshold. The SID will be flown to the point or fix at which the enroute phase begins.

(5) An FMS approach will be flown to the MAWP as published, and through the entire missed approach procedure.

210.4 ANALYSIS. Flight inspection of FMS procedures determines if the procedure is flyable and safe. If a new procedure is unsatisfactory, the flight inspector shall coordinate with the procedures specialist, ATC, and/or the proponent of the procedure, as applicable, to determine the necessary changes. When existing procedures are found unsatisfactory, notify the procedures specialist immediately for Notice to Airmen (NOTAM) action. The inspector shall evaluate the following items:

a. The controlling obstacles are verified. No peculiar hazards exist (for example, a ridgeline which could be encroached upon if an aircraft were to overshoot a WP or course due to wind.)

b. The procedure is technically sound: human factors are considered, cockpit workload is acceptable, and the procedure is not overly complex. Consider the types of aircraft that will be using the procedure (wide-body transport, large transport, and large business jet) during the evaluation.

c. If the FMS procedure overlies an existing procedure, there shall be no difference in the turnpoints or ground tracks between the two procedures. Report any differences observed between the FMS and underlying procedures.

d. The FMS procedure will satisfactorily deliver the aircraft to an established point which terminates the procedure (enroute fix, IAF, MAWP, etc.).

e. Waypoint spacing is sufficient to allow the aircraft to stabilize on each leg segment without jumping over waypoints/legs.

f. Communications and RADAR coverage, if required, is adequate for the entire procedure.

g. Surveillance inspection of airport lighting, runway/taxiway markings, IRU/ runway update reference points, etc., will be accomplished during the flight inspection of the FMS procedure.

210.5 TOLERANCES. The procedure shall be safe, practical, and easily interpreted with a minimum additional cockpit workload.

210.6 REPORTS. Documentation shall be completed in accordance with Section 108 of this manual and appropriate chapters and appendices of Order 8240.36, Instructions for Flight Inspection Reporting (latest revision). The General Characteristics Report, Form 8240-14, will be used for the report. The following information should be contained in the report:

a. Airport name, city, state. Procedure name, revision/effective date.

b. Underlying procedure name, revision/ effective date (if applicable).

c. Indicate aircraft type and type of navigation system used for the evaluation. If applicable, indicate software or data base revision number/effective date.

d. Report findings. List waypoints, waypoint types, or any other data necessary to clarify report. Include a statement that the procedure was satisfactory as proposed/published, or unsatisfactory, including the reason(s) and the coordination made to correct the procedure.

SECTION 211. COMMUNICATIONS

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SECTION 211. COMMUNICATIONS

211.1 INTRODUCTION. Air/ground communications services within the NAS are classified according to function. En route communications (ECOM) is the service provided between ARTCC controllers and pilots, and includes RCAG and BUEC facilities. Terminal communications (TCOM) is the service provided between approach and departure controllers and pilots in terminal airspace, including RCF and ATCT facilities. FSS communications (FCOM) is the service provided between FSS and pilot and are advisory in nature, such as EFAS. Other advisory services include ATIS, AWOS, and ASOS, all of which may be transmitted on a NAVAID or a discrete communications frequency.

211.2 Preflight Requirements. The flight inspector shall prepare for the flight inspection in accordance with the procedures outlined in Section 106. Coverage requirements, including tailored sector definitions, shall be provided by local facility maintenance and air traffic personnel.

211.3 Flight Inspection Procedures. The performance of communications facilities is accurately predicted by computer aided m odeling. Therefore, commissioning inspections are only required when requested by facilities maintenance engineering. Periodic inspections shall be conducted on a surveillance basis in conjunction with evaluation of associated navigation and air traffic control facilities.

211.31 Checklist.

Type Check	Reference Paragraph	C	P
TCOM	211.32011	1	2
ECOM	211.32012	1	2
ATIS	211.32013	1	2
AWOS/ASOS	211.32014	1	2

FOOTNOTES:

1. When requested.

2. Surveillance inspections conducted during other inspection evaluations.

211.32 Detailed Procedures.

211.3201 Coverage. When coverage cannot be predicted by facility engineering, a flight inspection will be requested. Evaluate facilities where the minimum en route altitude (MEA) is determined by communications coverage.

a. During requested commissioning inspections, coverage shall be determined by the air traffic service requirements established locally.

b. Flight profiles may vary according to the local requirements and could include an orbit or a detailed sector evaluation. Communications for fixes, hand-off positions, changeover points, or controlled airspace shall be checked.

c. Additional frequencies assigned to the same service requirement will not require a complete inspection, but should be evaluated on a surveillance basis.

d. Standby equipment shall be checked during any requested commissioning inspection.

211.32011 Terminal Communications (TCOM) includes tower, ground control, clearance delivery, departure, and arrival frequencies. Commissioning inspections, when requested, shall be conducted at the extremities of the airport to determine if there are blind spots and adequate coverage. Departure and arrival frequencies shall be checked to verify service throughout the established sector volume.

211.32012 En route Communications (ECOM) includes VHF and UHF air/ground frequencies and BUEC channels. When requested, these frequencies shall be evaluated throughout the established sector service volume.

211.32013 Automatic Terminal Information Service (ATIS) broadcast on a NAVAID facility shall be commissioned and reported with that NAVAID (see Section 201). When commissioning is requested, ATIS broadcast on a discrete communications frequency shall be checked in accordance with local requirements. Departure ATIS shall be verified at the airport extremities.

211.32014 Automated Weather Observing System (AWOS)/Automated Surface Aviation Observing System (ASOS). These systems provide local weather observations and may be broadcase on a NAVAID or a discrete VHF communications frequency. Transmission on a NAVAID shall be verified in accordance with Section 201 or 207. Local altimeter settings from these systems can result in lower minimums for standard instrument approach procedures.

Whenever this occurs, ensure that the associated procedure has been flight inspected to the new minimum prior to publication. When AWOS/ASOS is used as the primary airport altimeter source, flight inspection shall verify reception at or beofre the initial approach fix (IAF).

211.4 Analysis. Unsatisfactory conditions shall be brought to the attention of the appropriate air traffic control and facilities maintenance personnel.

211.5 Tolerances.

a. Coverage. Communications frequencies are engineered for distinct volumes of airspace which are guaranteed to be free from a preset level of interference from an undesired source. Each specific function has its own frequency protected service volume. Some are cylinders, while others are odd multi-point geometric shapes. These odd shapes are normally required for en route ATC functions. Following is a list of maximum altitude and radius dimensions recommended for each type of service. Under no circumstance will a service volume be approved at an altitude and distance greater than the radio line of sight (RLOS) distance (reference Figure 303-1).

Service	Altitude	Distance
ECOM		
	45,000	150
	25,000	60
TCOM		
Ground Control	100	5
Clearance Delivery	100	5
Local Control	25,000	30
Approach Control	25,000	60
Departure Control	25,000	60
ATIS		
Arrival	25,000	60
Departure	100	5
AWOS/ASOS	15,000	40
NAVAID	Section 201 or 207	
Discrete Comm	At or before the IAF	

211.6 Adjustments. All requests for facility adjustments shall be specific. Flight inspection certification shall be based on facility performance after all adjustments are completed.

211.7 Reports. Reports shall be prepared in accordance with Order 8240.36, Instructions for Flight Inspection Reporting (latest version).

211.8 Records and Notices to Airmen (NOTAM). See Section 107.

SECTION 212. DIRECTION FINDING STATIONS (DF)

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SECTION 212. DIRECTION FINDING STATIONS (DF)

212.1 Introduction. Direction finding stations use normal VHF or UHF communication transmissions from aircraft to determine bearing information from a ground station. Facilities maintenance personnel may then relay this information to an aircraft in flight to assist in determining the aircraft position. Doppler type VHF/DF is the standard equipment within the FAA. Older equipment, such as U.S. Navy VHF and UHF/DF facilities, may still be in use at certain locations. Operational performance and flight inspection procedures are the same for all DF equipment, with minor tolerance differences as noted in paragraph 212.5. AFIS is the accuracy standard, but non-AFIS equipped aircraft with suitable communication equipment may perform DF inspections when operated in accordance with appropriate sections in this manual. Direction Finding stations are normally located at or near airports and/or Flight Service Stations. Many DF facilities have the capability of providing an emergency instrument approach procedure where favorably sited with respect to an airport. Assuring the accuracy of these procedures is an integral part of the DF flight inspection.

212.2 Preflight Requirements

212.21 Facilities maintenance personnel shall prepare for flight inspection in accordance with procedures specified in Section 106. For commissioning inspections, facilities maintenance personnel should:

a. Prepare a detailed outline of any special information or procedure(s) desired as an outcome of the flight inspection;

b. Prepare the desired sequence for the inspection;

c. Optimize the facilities equipment.

d. Ascertain that fully qualified operators and maintenance technicians are available.

212.22 Flight Personnel shall prepare for the DF flight inspection in accordance with procedures specified in Section 106. Air crews shall:

a. For commissioning inspections, prepare a chart with the DF facility accurately plotted and appropriate radials and a 360 ° orbit drawn. The scale of the chart should be 1:500,000 (Sectional) or larger and the areas to be overflown evaluated per Section 214.

b. Obtain information from facilities maintenance personnel pertinent to the planned inspection, including desired outcomes, expected performance, and sequence of events.

c. For periodic inspections, obtain previous flight inspection data pertinent to the planned inspection.

212.3 Flight Inspection Procedures. The aircraft must be positioned precisely to determine bearing accuracy and service area. AFIS has the positioning capability to the accuracy standard required. Non-AFIS aircraft may perform the inspection if accurately plotted ground check points are selected and the aircraft can be safely maneuvered over these checkpoints. Where neither AFIS nor ground check point positioning is available, the theodolite shall be used. The DF operator will be briefed to compute all bearings as from the DF facility except for station passage and approach procedures.

212.31 Checklist. All of the checks listed below shall be performed on the commissioning flight inspection. Special flight inspections may require any one or all of these checks, depending on the reason for the inspection. Periodic inspection of bearing accuracy will be conducted in conformance with paragraph 212.32025.

Type of Check	Reference Paragraph	C	P
Preliminary Station Alignment	212.3201	X	
Bearing Accuracy	212.3202	X	
Communication and Coverage	212.3203	X	X
Station Passage	212.3204	X	X
Operator Performance	212.3205	X	X
Standby Power	212.3206	X	
DF Approaches	212.3207	X	X

212.32 Detailed Procedures.

212.3201 Preliminary Station Alignment.

a. Use AFIS and select an azimuth from the DF facility to establish an alignment reference. For non-AFIS aircraft, use the theodolite on a predetermined azimuth or select a checkpoint which lies within the quadrant of the planned orbit containing the maximum number of checkpoints. At an altitude which will assure radio line of sight, obtain a DF bearing from the operator and compare this bearing with the actual bearing determined from AFIS, the theodolite, or checkpoint.

b. If the DF bearing error is less than $\pm 6^{\circ}$, continue an orbital flight for at least 90° of azimuth. Non-AFIS aircraft will orbit in the direction of the maximum number of checkpoints; theodolite or AFIS orbit direction is at the discretion of the flight inspector and/or DF operator. If the remaining bearings in this primary quadrant are within $\pm 6^{\circ}$, proceed with the bearing accuracy check as required in paragraph 212.3202. If the reference or succeeding DF bearings in this primary quadrant exceed $\pm 6^{\circ}$ error, the equipment shall be adjusted and the procedure repeated. From the preliminary check, data should be derived to balance the overall error curve.

212.3202 Bearing Accuracy. DF coverage will not substantially exceed line-of-sight. Coverage is, dependent on power output, antenna height, terrain, and the effects of signal reflection. The bearing accuracy check is conducted to determine the ability of the DF facility to furnish accurate bearings throughout the service area during commissioning, and forms the reference for other inspections. This is done by comparing DF bearings from the facility with bearings measured from AFIS, theodolite, or ground checkpoints.

212.32021 AFIS Alignment and Orbit.

a. Proceed to the range appropriate to the facility and to the altitude previously determined. If HYBRID Mode is not available, use the minimum DME update altitude and plan to fly a second orbit for coverage if the minimum DME update altitude is higher than the intended use altitude. The AFIS will be programmed for the DF facility parameters (Identification, Latitude, Longitude, Magnetic Variation) inserted in the FI FAC series.

b. For initial facility alignment (reference), the AFIS system will be programmed for an RNAV Radial flight path, Inbound or Outbound, beyond 10 NM from the DF antenna. DF bearing accuracy may be determined by comparing the operator DF bearing to the bearing displayed on the CDU. RNAV/Autopilot coupled flight is recommended for Radial or Orbit maneuvers.

c. After the initial alignment has been accomplished, an Orbit CW or CCW will be programmed and flown. An event mark will be made on the recording at the position the transmitter is keyed for the DF steer; comparison can then be made to the 5° bearing marks on the analog recording.

212.32022 Theodolite Orbit.

a. The theodolite shall be aligned to read magnetic bearings from the DF station. It should be located adjacent to the DF site at a position where the aircraft will be visible throughout as much of the orbit as possible. This position should be less than 300 feet from the site. The flight inspector should brief the DF operator and the theodolite operator to avoid confusion during the actual flight inspection.

b. The theodolite operator shall track the aircraft throughout the orbit and actuate one event mark (1020 Hz tone) at each 10 degrees of azimuth. The pilot shall transmit for a DF bearing at frequent intervals and actuate the pilot event mark on the opposite side of the recording during each such transmission. The airborne technician shall label each of these event marks. The leading edge of the theodolite event mark will represent the actual bearing of the aircraft from the station, and the pilot event marks will represent the DF bearing. The airborne technician will label the DF bearing as reported by the DF operator and determine the error with the use of proportional ("Ten Point") dividers.

212.32023 Checkpoint Orbit

a. Position the aircraft over the predetermined checkpoints. Where possible, these checkpoints should be located at or near the limits of the DF and communication range capability to validate bearing accuracy and service area simultaneously. As the aircraft approaches the first ground checkpoint or measured bearing, the pilot shall transmit a 10-second radio signal, timed so that the aircraft will be over the checkpoint in the middle of the transmission. Compare the bearing provided by the DF operator with the measured magnetic bearing. Note each DF bearing, magnetic bearing, error, radio frequency, altitude, and distance on the flight inspection report. Bearing errors shall be computed in the same manner as VOR course alignment errors; i.e., when the aircraft bearing is less than the bearing reported by the DF operator, the error is negative.

b. Proceed with the orbit of the facility at the appropriate range and altitudes, obtaining bearings as often as practical. After initial contact has been established, a 5 to 10 second radio signal is usually sufficient to obtain bearings. Because of the capability of almost instantaneous readout on the Doppler type DF, a five-second radio signal is usually sufficient to obtain bearings on this type facility.

c. If communications become unsatisfactory, or if bearing errors exceed tolerance, climb above the altitude being flown until adequate communications are established again and/or bearing errors are satisfactory.

d. If communications and bearing accuracy remain satisfactory on the next measurement, descend to the appropriate selected altitude or to the minimum altitude which will provide satisfactory bearings and communications, whichever is higher, and continue to the next checkpoint. This procedure will provide the lowest altitudes throughout the coverage area of the DF facility at which acceptable bearing information and communication can be expected.

212.32024 Analysis of Bearing Accuracy. After completing the bearing accuracy check, station adjustment may be necessary to balance station error and keep all bearings within tolerance. Whenever bearing errors are very large in a particular area and normal elsewhere, it may be advisable to investigate the area further by checking radially or by partial orbits at different ranges. When an out-of-tolerance condition cannot be corrected, the controller shall be advised of the area(s) which are not to be used. The condition(s) will be noted on the flight inspection report and the facility assigned a "restricted" classification. A NOTAM will not be issued.

212.32025 Periodic Inspections will coincide with the periodicity schedule per Section 105 of this manual. Periodic inspections will consist of at least one bearing accuracy check in each quadrant, approaches based on the facility, and communication checks on the primary frequencies. Every other periodic inspection (900 days), a full orbit will be accomplished per paragraph 212.32026 and include DF approaches where utilized. Coverage shall be evaluated during all inspections.

212.32026 Commissioning Inspection

a. An orbit procedure, as outlined in paragraph 212.3202, shall be used to evaluate bearing accuracy for the commissioning flight inspection. Orbit radius shall be the minimum of:

(1) 40 miles for Doppler DF facilities;
(2) 30 miles for older equipment;
(3) operational requirements

The altitude shall be 1500 feet AGL, an altitude which will provide obstacle clearance in the area within 5 miles of the orbit, or minimum radio line of sight, whichever is the highest.

b. AFIS or theodolite bearings may be taken at frequent intervals as close together as 10°. A minimum of four bearings shall be taken for each quadrant, regardless of which orbit method is used.

212.3203 Communications Coverage

a. Voice communication is the means for getting DF information to a pilot. Quality of communications greatly affects the capability of the DF to provide quality service. Bearings shall be obtained on as many of the published frequencies as practical during the checkpoint orbit. For a commissioning inspection, all frequencies proposed for use will be checked. This may be accomplished on the orbit or during radial flight at the extremes of coverage. For periodic inspections, voice communications will be checked on all frequencies if less than four are used for DF bearings. If more than four are available, at least four frequencies will be checked.

b. Coverage is considered satisfactory where bearing accuracy meets tolerances at the required orbital altitude and distance, per paragraph 212.32026a. Where coverage is required at greater distances for special purposes, it can be determined by either orbital or radial flight at the greater distance and altitude.

212.3204 Station Passage. Fly inbound to the DF antenna from a position at least 5 miles out and an altitude of 1500 feet above the antenna. Obtain sufficient steers from the DF operator to overfly the antenna and note the distance from the aircraft to the DF antenna when the operator reports station passage. This check may be performed in conjunction with the DF approach procedure (Paragraph 212.3207) at the discretion of the pilot and DF operator.

212.3205 Operator Performance. The flight inspector must determine that the overall system is safe and reliable. The operator should be able to direct the aircraft over the facility, report station passage, and provide pertinent information relative to the use of DF service. If an emergency approach procedure has been established (DF approaches are not SIAPs), the operator should be able to direct the aircraft to a position from which a safe landing can be made.

212.3206 Standby Power.

a. Standby power, if installed, shall be checked on the commissioning inspection to ensure that no derogation of communication or bearing accuracy occurs when using the alternate power source. An orbit on each source will be performed and the bearing accuracy and overall station error compared. If standby power is installed at a later date, the facility will be inspected on standby power at the first periodic inspection scheduled after the installation of the standby power system. Inspections after a change in the standby power source are at the discretion of the Airway Facilities Engineering Division.

b. Periodic inspections normally will not require the use of standby power systems. Airway Facilities personnel may request a check on standby power if they suspect that the alternate power source causes a deterioration in the performance of the DF facility.

212.3207 DF Approaches.

a. The emergency DF approach shall be checked at the time of commissioning, during all periodic inspections, or whenever an emergency procedure based on the DF facility is established. Airway Facilities personnel or DF facility operators may request a check of the approach during any inspection if, in their opinion, verification of the procedure or equipment performance is desired. As a minimum, the emergency DF approach procedure will be checked during alternate periodic inspections (900 days).

b. Conduct the approach in accordance with the DF operator's instructions and evaluate the obstacle clearance and flyability per Section 214. The flight inspector shall note the position of the aircraft relative to the airport and determine whether it will permit a safe landing.

212.4 Standby Equipment. Where installed, standby equipment will meet the same operational tolerances during commissioning as the primary equipment. Periodic inspection of standby equipment is not required unless requested by Airway Facilities, Engineering, or the DF operator.

212.5 Tolerances. All DF stations shall conform to these tolerances for an UNRESTRICTED classification. Classification of the facility is the responsibility of the flight inspector.

a. Bearing Accuracy

VHF/DF, UHF/DF: Each DF bearing must be within 10° of the actual bearing.
VHF/DF (doppler): Each DF bearing must be within 6° of the actual bearing

b. Coverage

VHF/DF UHF/DF: 30 miles
VHF/DF (doppler): 40 miles

c. Communications. Communications on all required frequencies shall be clear and readable throughout the coverage area.

d. Station Passage. Station passage must be recognized within 1 1/2 miles at 1500 feet AGL.

e. Controller Performance. Controllers shall be capable of directing an aircraft to the station, reporting station passage, providing guidance for an emergency approach, and vectoring aircraft to avoid terrain and obstacles.

f. Standby Power. The DF facility will meet all tolerances in this section when operating on an alternate power source.

g. Emergency Approaches. Where a DF approach procedure is established, the system shall provide the capability of directing the aircraft to a position from which a safe landing can be made.

212.6 Adjustments. Equipment adjustment shall be made to balance the overall station error.

212.7 Records, Reports, and Notice to Airmen. For commissioning flight inspections, a graphic representation of the course error (error curve) shall be constructed and included as part of the flight inspection record. The commissioning error curve and the original map(s) used to plot the DF facility, DF approaches, and terrain and obstacles will be included in the permanent facility file. (See Sections 107 and 108).

SECTION 213. GLOBAL POSITIONING SYSTEM (GPS)

213.1 INTRODUCTION. This Section details the flight inspection procedures and tolerances to be applied to Global Positioning System (GPS) approach procedures.

213.2 PREFLIGHT REQUIREMENTS (Flight Personnel). The flight inspector shall prepare for the flight inspection in accordance with the procedures outlined in Section 106.

213.3 FLIGHT INSPECTION PROCEDURES

213.31 Nonprecision Approach Checklist

Type Check	Ref. Para.	C	P
Initial/Intermediate Approach Segment	213.321	X	
Final Approach Segment	213.321	X	
Missed Approach Segment	213.321	X	
SIAP	214.3		X

213.32 Detailed Procedures. The entire flight plan of waypoints (IAWP to MAHWP) will be entered into the GPS receiver for commissioning flight inspections and selected from the GPS receiver data base for periodic inspections.

213.321 Terminal Segments (IAWP, IWP, FAWP, MAWP, MATWP, MAHWP).

a. Purpose. To evaluate the waypoint data accuracy and GPS position determination throughout the area comprising the standard instrument approach procedure.

b. Positioning.

(1) Initial and intermediate segment evaluation may be performed when flying by the waypoint if it is depicted as a turn point on the procedure. Intermediate and missed approach segments shall be flown at procedural altitudes.

(2) The final approach segment positioning shall be such that all waypoints depicted in a straight line are evaluated by flying over the waypoint and evaluating GPS positioning determination and delivery alignment. Position the aircraft to fly from three miles outside the first waypoint in a straight line (normally an IWP or FAWP) and overfly all waypoints to the MAWP. Final approach segments shall be flown to 100 feet below the published altitude from the FAWP to the MAWP.

c. The automated flight inspection system (AFIS) shall be the standard for the final approach segment evaluation.

d. Evaluation.

(1) During commissioning flight inspection, terminal approach segment data integrity shall be evaluated by comparison of procedural waypoint data to the flight plan waypoint data entered into the flight inspection GPS system by database or the pilot. Prior to the approach being flown, the flight plan data shall be compared to the procedural data to ensure bearings and distances between waypoints reflect the procedure design.

(2) The AFIS will correct between the FAWP and MAWP if position updates are used.

213.4 FLIGHT INSPECTION ANALYSIS

213.41 Procedural/Design Data Base Integrity. The procedure shall be evaluated to verify the geodetic coordinates (waypoints) are correct. AFIS will display the bearing and distance from each waypoint to the next in the flight plan. These values shall be compared to the procedural design and shall meet the requirements of Paragraph 213.5.

213.42 Standard Instrument Approach Procedure (SIAP). The instrument flight procedure shall be evaluated to ensure flyability and safety. This evaluation and analysis shall be performed in accordance with Section 214, throughout the procedure, including the missed approach segment.

213.43 Position Determination. WPDE shall be evaluated to verify accuracy with the procedural design and the tolerance in Paragraph 1.5.

213.44 Electromagnetic Spectrum. The RF spectrum from 1200 to 1250 MHz and 1555 to 1595 MHz should be observed when GPS parameters indicate possible RF interference. Interfering signals are not restrictive unless they affect the receiver/sensor performance. The SNR values being recorded may indicate RF interference problems. The normal GPS signal strength is -130 to -123 dBm. Use the SNR values along with the spectrum analyzer to investigate the RF interference, the location of its occurrence, and possible sources. Particular attention shall be given to harmonics on or within 20 MHz of GPS L1 (1227.6 MHz) and those on or within 10 MHz of GPS L2 (1575.42 MHz). Report any electromagnetic spectrum anomalies or suspected anomalies encountered to the Program Director for Spectrum Policy and Management.

213.5 TOLERANCES. During final approach evaluation, GPS performance shall meet the following tolerances:

Parameter	Ref. Para	Tolerance/Limit
Procedure/ Database Integrity	213.41	
True Bearing to next WP		± 2^0
Distance to next WP		± 0.3 nm
WPDE	213.43	835 ft.

213.6 Records, Reports, and Notices to Airmen. See Sections 107 and 108.

SECTION 214. FLIGHT INSPECTION OF INSTRUMENT FLIGHT PROCEDURES

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SECTION 214. FLIGHT INSPECTION OF INSTRUMENT FLIGHT PROCEDURES

214.1 INTRODUCTION. Instrument flight procedures specify standard routings, maneuvering areas, flight altitudes, and visibility minimums for instrument flight rules (IFR). These procedures include airways, jet routes, off-airway routes, standard instrument approach procedures (SIAP), standard instrument departure procedures (SIDs), standard terminal arrival routes (STARs), and procedures predicated on the use of Flight Management Systems (FMS) and Global Positioning System (GPS). All new and revised procedures are subject to flight inspection.

214.2 PREFLIGHT REQUIREMENTS

a. The Procedure Specialist shall complete the coordination required with all affected entities for the development or revision of an instrument flight procedure. All data necessary for conducting the flight inspection shall be delivered to the responsible Flight Inspection Office (FIO) or International Flight Inspection Office (IFIO) and shall include a briefing if special factors relative to the procedure are necessary.

b. Procedural data shall include the following as a minimum:

(1) Charts of sufficient detail to safely navigate and identify considerable terrain, obstacles, and obstructions (e.g., 1:500,000 for en route procedures, 1:100,000 for terminal procedures). Map overlays are permitted if they are permanently attached to the charts;

(2) Documentation of all known terrain, obstacles, and obstructions in the primary areas with the map study/data base determined controlling subject identified; secondary obstructions shall be identified if the object or terrain impacts the procedure;

(3) Minimum (and maximum where applicable) altitudes determined to be usable from map study and data base information for each segment of the procedure;

(4) Narrative description of the procedure;

(5) Plan and profile views for SIAPs;

(6) Data for each fix, intersection, and holding pattern;

(7) Communication applicable to each segment of the procedure;

(8) Airport marking and any special local operational procedure (e.g., noise abatement, non-standard traffic patterns, lighting activation).

c. Current forms are acceptable from established organizations involved in the development of instrument procedures. If the procedures package as delivered to the FIO or IFIO is inconsistent with this section, the package will be returned intact to the developing organization and the transaction logged for the quarterly report on procedures flight inspection, AVN-200. The flight inspector shall identify deficiencies on a comment sheet to accompany the returned procedures package.

d. Two copies of the procedure will be provided to the flight inspection field office. One copy shall remain at the office. The second copy goes to the crew, which may make copies of all or portions of the procedures package at their discretion to distribute to crew members.

214.3 FLIGHT INSPECTION PROCEDURES

a. The objective of evaluating instrument flight procedures is to ensure safety and flyability. The following items are included in this evaluation:

(1) Aircraft maneuvering is consistent with safe operating practices for the category of aircraft intending to use the procedure.

(2) Cockpit workload is acceptable.

(3) Navigation charts properly portray the procedure and are easily interpreted.

(4) Runway markings, lighting, and communications are adequate.

(5) The applicable system (NAVAID, Satellite, FMS, etc.) supports the procedure.

References in this section are for clarification purposes only and do not supersede instructions or flight inspection criteria for facilities or systems contained elsewhere in this order.

b. A restricted NAVAID may still support an instrument flight procedure when the procedure does not use the out-of-tolerance area. Those areas shall be reflected on the flight inspection report and on the navigation charts where performance will restrict or limit the expected procedure.

c. A distance measuring equipment (DME) arc segment may be used in areas of unusable radial information, provided that the DME, the radial where the arc starts, the lead radial, the final approach radial, and any other radial used in the procedure meet required tolerances.

d. The flight inspection of an instrument flight procedure and verification of the SIAP obstacle data may be conducted during the applicable system inspection if visual meteorological conditions (VMC) prevail throughout each segment of the procedure to be evaluated.

e. Verification of Obstacle Clearance

(1) General. An on-site evaluation shall be conducted during the development of original flight procedures for routes and airports having no prior IFR service to verify obstructions in each segment. The obstruction evaluation may be accomplished by airborne or ground observation.

(2) Identification of New Obstacles. In most instances, accurate information concerning the location, description, and heights of tall towers and other considerable obstacles is available from the FAA data base and/or other government sources. When a new obstruction not identified in the procedures package is discovered and becomes the controlling obstruction for the segment, the procedure commissioning will be denied until the procedure specialist can analyze the impact of the obstacle on the overall procedure.

(3) Determination of Obstacle Heights. When a new controlling obstacle not identified from current data base information is discovered, e.g., a tower less than 200 feet AGL, the flight inspector will ascertain via the safest and most expeditious method available the exact location and height of the new obstruction and forward the information to the procedure specialist listed on the request for flight inspection cover sheet. Obstacle heights measured in flight will not be used unless the actual height of the terrain or obstruction cannot be determined by other means. If inflight height determination is required, accurate altimeter settings and altitude references must be used to obtain precise results.

An alternative method for determining obstacle height is to select another obstacle in the near vicinity which has a known or published elevation. Fly abeam the uppermost point of the known obstacle and set the altimeter to read the same mean sea level (MSL) altitude as published. Without resetting the altimeter, fly abeam of the obstacle for which the height is unknown and note the altimeter reading. Where possible, note the AGL elevation for the procedure specialist and any deviation from the above procedure necessary to compensate for unlevel terrain.

The flight inspection report will reflect the documentation for the method of height determination.

214.31 Checklist.

Check	Ref. Para.	C	P
Final Approach Segment	214.32011	X	X
Missed Approach Segment	214.32012	X	X
Circling Segment	214.32013	X	1
En route/Terminal Segments	214.3202	X	1
Fixes/Holding Pattern	214.3203	X	1
Air/Ground Communications	214.3204	X	1
Area Navigation/ GPS/FMS	214.3205	X	2

NOTE:

1. Surveillance.

2. SIAPs require periodic inspection per Section 105.

214.32 Detailed Procedures.

214.3201 Approach Segments. Controlling obstacles in each approach segment shall be confirmed visually by inflight or ground observation. If unable to confirm that the declared controlling obstacle is the highest obstacle in the segment, list the location, type, and approximate elevation of the obstacles the flight inspector desires the procedure specialist to consider. The flight inspector will place special emphasis on discovered obstacles that may not be listed in the FAA data base. If the flight inspector observes that the controlling obstacle has been eliminated or dismantled, the flight inspector shall forward that information to the procedures specialist.

Conduct obstacle evaluations in visual meteorological conditions (VMC) only. The flight inspector retains the responsibility to ensure that the procedure is operationally safe and may use his/her discretion to vary the pattern to best suit the evaluation. Obstructions located near the edge of the boundaries may require flying the trapezoid as determined by the procedures specialist. For precision approaches with sloping obstacle clearance planes, only surveyed data should be used when considering obstructions.

214.32011 Final Approach. The final approach course shall deliver the aircraft to the desired aiming point. The aiming point varies with the type of system providing procedural guidance and will be determined by the procedure specialist. After flight inspection verifies the aiming point, it will not be changed without the concurrence of the procedure specialist. When the system no longer delivers the aircraft to the established aiming point and the system cannot be adjusted to regain the desired alignment, consideration should be given to amending the procedure.

214.32012 Missed Approach. Flight inspection of the missed approach segment will assure that the designed procedural altitudes provide obstacle clearance per paragraph 214.3e. The flight inspector shall also determine that the procedure is safe and operationally sound for the category aircraft intended.

214.32013 Circling. The flight inspector shall verify that proposed circling maneuvers are safe and sound for the category of aircraft proposed. Procedural altitudes shall be evaluated per paragraph 214.3e.

214.3202 En route/Terminal Routes. Evaluate each en route or terminal segment during commissioning flight inspection to ensure that the proposed minimum obstacle clearance altitude (MOCA) is adequate per paragraph 214.3e.

214.32021 Minimum En route Altitude (MEA) and Changeover Points. The MEA and changeover points shall be predicated on minimum obstruction altitude (MOCA), minimum reception altitude (MRA), airspace, and communication requirements. If more than one of the above altitudes is procedurally required, the highest altitude determined through flight inspection will become the minimum operational altitude.

214.32022 Maximum Authorized Altitudes (MAA). MAAs are limitations based on airspace restrictions, system performance characteristics, or interference predictions. If the MAA are based on an interference problem, the source of the interference must be identified and corrective action initiated where possible.

214.3203 Fixes/Holding Patterns. Controlling obstacles shall be verified to ensure the adequacy of minimum holding altitude (MHA) per paragraph 214.3e. System performance will be evaluated to ensure conformance with appropriate tolerance sections of this manual. If system performance and obstacle clearance data are on file, flight inspection of the procedure is not required.

214.3204 Air/Ground Communications. Air/ground communications with the controlling facility must be satisfactory at the minimum initial approach fix altitude and at the missed approach altitude. Where ATC operations require continuity in communication coverage and ATC requests verification, flight inspection shall evaluate that coverage in accordance with appropriate sections of this order.

214.3205 Area Navigation (RNAV), GPS, FMS. All procedures based on RNAV, GPS, or FMS shall be evaluated by flight inspection for conformance to safe and sound operational practices. Flight inspection of these procedures shall, as a minimum, evaluate the following:

a. Waypoint accuracy;

b. Bearing accuracy;

c. Distance accuracy;

d. Conformancy with paragraph 214.3a;

e. Obstacle clearance per paragraph 214.3e;

f. System support of the procedure at altitudes proposed for use

214.32051 Detailed Procedures

a. The flight inspector shall review and evaluate each segment of the procedure for conformance with safe and sound operational practices. Where required, the flight inspector shall coordinate and brief ATC on special handling requirements and procedural operation. Prior to flight, the inspector shall verify that all supporting equipment or systems are in place and functioning (e.g., Rho Theta systems in operation, satellite ephemeral data and availability, etc.).

(1) Waypoint Accuracy. The purpose is to verify that the waypoints as depicted on the procedure are properly labeled and correct. Rho-Theta systems shall properly depict supporting facilities; systems utilizing coordinates are depicted in a manner compatible with equipment requirements. Where fix displacement areas are applicable, the displacement area will be depicted and the waypoint considered accurate if the system consistently delivers the aircraft to a point within the fix displacement area. Where specific equipment tolerances or displacement errors are addressed in other portions of this order, the procedure will comply with tolerances listed in the appropriate section.

(2) Bearing Accuracy. AFIS is the standard for determining the bearing accuracy to and between waypoints. The procedurally depicted bearings will agree with the bearings announced from AFIS. Where there is disagreement, the procedure will be denied and the procedure specialist advised.

(3) Distance Accuracy. AFIS is the standard for determining the distance accuracy between waypoints. Where there is a difference between depicted waypoints and AFIS, the procedure will be denied and the procedure specialist advised.

(4) The flight inspector shall evaluate all facets of the procedure to ensure compliance with safe operating practices. The evaluation shall include the clarity and readability of the depiction and that workloads imposed on the air crew to select or program the procedure are reasonable and straightforward. Objective and professional judgment from air crews trained in flight inspection is expected.

(5) Runway Markings, Lighting, and Communication. The flight inspector shall evaluate the suitability of the airport to support the procedure. Unsatisfactory or confusing airport markings, non-standard or confusing lighting aids, or lack of communication at critical flight phases are grounds for denying the procedure. In all cases, the procedure specialist will be appraised of the conditions discovered during the flight inspection.

(6) Applicable System Support. The variation in systems dictates a progressive approach in determining evaluation methods. Study of the procedure by the flight crew prior to flight will normally reveal the type of system verification required. Where a ground-based NAVAID supports the procedure, the flight inspector shall verify its status prior to flight. For satellite systems, the flight inspector shall study the satellite prediction charts for the optimum period for flight inspection (least number of satellites available). RNAV systems, such as FMS, TLS, and curved MLS approaches, will be evaluated through emulation with AFIS aircraft. Where emulation is not possible, the procedure will be performed in an aircraft certified for the procedure with the flight inspector aboard and in a position where evaluation per paragraph 214.32051a(4) can be accomplished.

b. En route and terminal route segments shall be flown at the proposed MEA using the applicable system for guidance and to or from a point where course or obstacle clearance has been established. In the case of a SID, the procedure shall be evaluated to an established NAVAID or fix or to a point where en route obstacle clearance has been established. For STAR type procedures, the route shall be evaluated from where it departs known obstacle clearance and guidance to where the route intercepts a portion of an established SIAP or procedure from which a normal descent and landing can be accomplished. Periodic inspection of en route and terminal route segments is not required.

c. Standard Instrument Approach Procedures (SIAP). All standard instrument approach procedures intended for publication shall be inflight evaluated. The final approach trapezoid shall be evaluated per paragraph 214.3e. The final approach segment shall be flown to an altitude 100 feet below the proposed minimum descent altitude. Approaches with precision vertical guidance shall be evaluated to the proposed decision or missed approach altitude. Misalignment or inaccurate data indications will be forwarded to the procedure specialist for further review prior to commissioning the procedure.

214.4 ANALYSIS. Flight inspection determines that the procedure is flyable and safe. If a new procedure is unsatisfactory, the flight inspector shall coordinate with the procedure specialist to determine the necessary changes. When an existing procedure is found unsatisfactory, initiate NOTAM action immediately and advise the procedure specialist.

214.41 Cartographic Standards. Changes to cartographic standards are the responsibility of the Interagency Air Cartographic Committee and the Intra-Agency Committee for Flight Information. Recommendations for changes to these standards should be sent to the Office of Aviation System Standards, Flight Inspection Operations Division, AVN-200, for consolidation and forwarding to the appropriate committee.

214.42 Night Evaluations.

a. For new flight procedures at airports with no prior IFR service, a night flight inspection shall be conducted to determine the adequacy of airport lighting systems prior to authorizing night minimums.

b. Inspect light systems during the hours of darkness. Evaluate the light system for:

(1) Faithful representation of the depiction (correct light pattern);

(2) Operation in the manner proposed (e.g., photocell, radio control etc.);

(3) Local lighting patterns in the area surrounding the airport do not distract, confuse, or incorrectly identify the runway environment.

214.43 Human Factors are concerned with optimizing the relationship between people and their activities by systematic application of human sciences integrated within the framework of systems engineering. In the context of flight inspection, it is a question of whether a flight procedure is operationally safe and flyable for a minimally qualified sole pilot flying an aircraft with basic IFR instrumentation in instrument meteorological conditions using standard navigation charting.

The criteria used to develop instrument flight procedures represent many factors such as positioning requirements, protected airspace, system and avionics capabilities, etc. Human factors such as cockpit workload, pilot error, and memory limitations have been considered. Sensory, perceptual, and cognitive restrictions historically have been incorporated in the criteria only to a limited extent; e.g., length of approach segments, descent rates, turn angles, etc. These are products of subjective judgments in procedure development and cartographic standards. It is incumbent upon the flight inspector to apply the principles of human factors when certifying an original or amended procedure. The following factors shall be evaluated:

a. Complexity. The procedure should be as simple as possible. It should not impose an excessive workload on a sole pilot flying a minimally equipped aircraft.

b. Interpretability

(1) The final approach course should be clearly identifiable, with the primary guidance system or NAVAID unmistakable;

(2) The procedure should clearly indicate which runway the approach serves and indicate which runway(s) circling maneuvers apply to;

(3) Areas not to be used for maneuvering shall be clearly defined.

c. Human Memory Considerations. Pilots must be able to extract information quickly and accurately during an instrument approach. Multiple tasks complicate the memory process and tend to produce prioritization during stressful phases of flight. Workload reduction can be accomplished through methodical chart layout that encourages the pilot to periodically refer to the depicted procedure rather than trying to memorize complex maneuvers.

214.5 TOLERANCES. The procedure should be safe, practical, and easily interpreted with minimal additional cockpit workload. Supporting facilities/ systems shall meet tolerances of the appropriate sections of this manual and not contribute to operational confusion.

a. Distance Accuracy. Unless otherwise permitted in applicable sections of this order, distance accuracy is to the nearest one nautical mile for all en route segments and to the nearest one tenth of one nautical mile for all terminal route segments.

b. Bearing Accuracy. The depicted bearings on all procedures shall agree with the AFIS announced bearing when the AFIS bearing is rounded to the nearest whole degree.

c. System Fix Displacement. The system must consistently deliver the aircraft to a point within the fix displacement area as depicted by the procedure specialist.

214.6 ADJUSTMENTS. See Section 106, paragraph 106.45.

214.7 REPORTS. The flight inspector shall certify that the procedure has been checked and the controlling obstacles verified. The facility/system flight inspection report and the appropriate procedure or SIAP documentation shall be completed.

should be sent to the Office of Aviation System Standards, Flight Inspection Operations Division, AVN-200, for consolidation and forwarding to the appropriate committee.

214.42 Night Evaluations.

a. For new flight procedures at airports with no prior IFR service, a night flight inspection shall be conducted to determine the adequacy of airport lighting systems prior to authorizing night minimums.

b. Inspect light systems during the hours of darkness. Evaluate the light system for:

(1) Faithful representation of the depiction (correct light pattern);

(2) Operation in the manner proposed (e.g., photocell, radio control etc.);

(3) Local lighting patterns in the area surrounding the airport do not distract, confuse, or incorrectly identify the runway environment.

214.43 Human Factors are concerned with optimizing the relationship between people and their activities by systematic application of human sciences integrated within the framework of systems engineering. In the context of flight inspection, it is a question of whether a flight procedure is operationally safe and flyable for a minimally qualified sole pilot flying an aircraft with basic IFR instrumentation in instrument meteorological conditions using standard navigation charting.

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SECTION 215. SURVEILLANCE RADAR AND AIR TRAFFIC CONTROL RADAR BEACON SYSTEM (ATCRBS)

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SECTION 215. SURVEILLANCE RADAR AND AIR TRAFFIC CONTROL RADAR BEACON SYSTEM (ATCRBS)

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SECTION 215. SURVEILLANCE RADAR AND AIR TRAFFIC CONTROL RADAR BEACON SYSTEM, (ATCRBS)

215.1 INTRODUCTION. This section outlines procedures for the flight inspection of surveillance radar and the air traffic control radar beacon system (ATCRBS). The procedures for radar flight inspection differ from the procedures for NAVAID's in that most of the data collection and analysis are conducted on the ground. The flight inspector's role in the radar environment is primarily one of providing a known target in a designated area. Present digital techniques allow the evaluation of many radar parameters by the use of statistical sampling of aircraft returns in the normal day-to-day radar environment. Although certain requirements must be completed using a flight inspection aircraft, facilities maintenance personnel should use targets-of-opportunity, radar data analysis (RDAS) tools, and other test equipment to the extent practicable for completing all checklist requirements. Facilities maintenance personnel will normally evaluate and document all radar facility performance parameters except those specifically evaluated by the flight inspector. Airway Facilities will prepare a radar inspection plan for all commissioning inspections, as well as all special inspections involving coordination outside the facility of concern. Joint use facility (radar data used by both FAA and DOD) inspection plans require coordination between the FAA region and the DOD user.

215.11 Primary Radar. Primary radar relies on reflected radio energy to provide a video target on the controller's display. The radar return varies in strength due to atmospheric conditions, target range, radar cross section, aircraft reflective surfaces, and other phenomena.

215.12 Secondary Radar. Secondary radar, referred to as ATCRBS, overcomes some of the basic problems of primary radar. Secondary radar relies on electronic replies from a transponder system in the aircraft which are generated as a result of interrogations from a ground-based system. Transponder replies can be used for improved target identification (assigned beacon code) and for aircraft altitude information from Mode-C equipped transponders. The ATCRBS normally provides improved coverage over primary radar. As with primary radar, the ATCRBS coverage is a function of many factors; e.g., siting, antenna patterns, etc. Although a separate system, the ATCRBS is normally inspected simultaneously with the primary radar system.

215.2 PREFLIGHT REQUIREMENTS/INSPECTION PLAN The AF regional maintenance engineering office and/or military equivalent is responsible for preparing the inspection plan. AT and the appropriate FIO shall assist in the coordination required for the plan. The plan shall fulfill five major functions: accomplish necessary coordination; list operational requirements; provide the necessary data; provide notification of the event; and establish the inspection schedule. An inspection plan is required for all commissioning radar inspections and special inspections involving pre-inspection coordination outside the facility of concern. Simple special inspections that do not require coordination outside the local AF/Maintenance and AT offices may not require a formal inspection plan but should always be documented. The USAF RADES will participate in the planning and inspections of a JSS site.

215.21 Facilities Maintenance Personnel. The appointee preparing the commissioning inspection plan shall coordinate with all associated offices. For en route sites, the attendees shall be: AF representatives from the ARTCC and the remote site, AT representatives from the regional office and the ARTCC, and appropriate FIO representatives. The DOD user and appropriate RADES representative should attend planning meetings to identify operational requirements and evaluation objectives for a JSS. For terminal radar inspections, the appointed coordinators shall include AT representatives from the region and local site, an AF representative from the sector office, and a FIO representative. Military offices shall provide plan preparation and the required coordination for joint use and military sites. The appointee for special plan preparation shall be assisted by representatives from each office of concern. This assistance will be requested from specific offices when required. In addition to the procedures specified in Section 106, facilities maintenance personnel shall:

a. The Objectives of the Inspection. These objectives will determine who shall assist and provide input for the draft of the plan and the methods used to perform the various checks and what checks will be performed by facilities maintenance personnel and flight inspection.

b. Prepare a List of Operational Requirements. These requirements shall describe in detail all routes, fixes, holding patterns, and approach and departure procedures. These details shall include specified altitudes, distances, and other pertinent information. The list of routes, fixes, etc., may then be divided between evaluations using targets-of-opportunity and those requiring a flight inspection aircraft. A flight inspection aircraft will normally be used in areas with low traffic activity, where siting criteria predicts marginal or no coverage, or where fix/map accuracy must be determined. The flight inspection phase of the plan may be further divided into checks requiring an aircraft with a calibrated transponder and those which can be completed using a small aircraft equipped with an approved transponder. When assigned to inspect or evaluate a military/JSS facility, the RADES evaluation officer shall perform all coordination and notification requirements, complete the flight phase planning, and publish required documents.

c. Describe the Resources Required. This list shall include personnel, aircraft, special tools and equipment, equipment calibration, computer time and software, charts, graphs, maps, etc. The inspection plan shall also include all data required to prepare, conduct, and document the inspection.

d. Flight Scheduling. Recommend, if appropriate, the best flight period for evaluating coverage. The flight period will usually be a compromise between operational and engineering needs. This compromise is required because AT prefers to handle flight inspection aircraft during periods of low traffic activity; however, the AF engineer may require some portions of coverage checks during peak traffic periods.

e. Radar Equipment Performance. Ensure the radar equipment is tuned to facility operational specifications prior to the flight inspection. A joint inspection is required to measure and optimize JSS equipment parameters.

f. Participating Personnel. Ensure participating maintenance and operations personnel (including military) are experienced and familiar with the objectives of the inspection and the requirements of this order.

g. Inspection Plan Ensure the inspection plan includes a sequence of events to minimize aircraft flight time and the inconvenience to operating traffic. This portion of the plan shall be used as a schedule of events during the inspection activities.

h. Final Plan. Ensure the final plan is reviewed and signed by representatives from AT, the FIO, the military when appropriate, and AF.

i. Consolidated Inspection Data. Consolidate and evaluate all inspection data obtained using targets-of-opportunity and advise the flight inspector of additional checks that require the use of a flight inspection aircraft.

j. Interrogator Calibration Values. Furnish the interrogator power values (in watts at the antenna) for inclusion in the flight inspection report.

215.22 Flight Personnel. Prepare for the flight inspection in accordance with Section 106. In addition:

a. Flight Inspection Coordinator. The FIO shall appoint a qualified flight inspection pilot as coordinator for each commissioning radar inspection, and special inspection as required, in accordance with paragraph 215.21.

b. Inspection Plan. A copy of the inspection plan and a current briefing concerning the operational requirements, expected facility performance, and the performance evaluations obtained using targets-of-opportunity shall be provided to the flight inspector. This information will be used to determine the extent of the flight inspection.

c. Checklist Requirements. Assist facilities maintenance personnel in determining which checklist requirements have been completed. The role of the flight inspector will vary greatly depending upon the type, sophistication, intended use, and location of the radar facility. For instance, an FAA en route radar may only require the flight inspector complete a portion of the vertical coverage check, whereas a mobile terminal radar may require a dedicated aircraft for all the checklist requirements.

d. Aircraft Requirements. Flight inspection aircraft used for ATCRBS and primary radar checks are equipped with a transponder that has been FAA-calibrated in accordance with applicable avionics maintenance standards. The transponder power output and sensitivity are pilot-selectable per the following table.

TRANSPONDER SWITCH SETTINGS AND CORRESPONDING TRANSPONDER POWER OUTPUT AND RECEIVER SENSITIVITIES

FLT INSP SELECT	LO-POWER SELECT	TX PWR OUTPUT	RX SENSI-TIVITY
OFF	OFF	Normal (350 Watts)	Normal (-75 dBm)
ON (Barber Pole Lit)	OFF	Normal (350 Watts)	Low (-69 dBm)
ON (Barber Pole Lit)	ON (Barber Pole Lit)	Low (88 Watts)	Low (-69 dBm)

215.3 FLIGHT INSPECTION PROCEDURES

a. General. Radar flight inspections may vary from a single (special inspection) requirement such as radar coverage over a new air traffic "fix," to a complete en route radar commissioning inspection at an ARTCC. The number of personnel, coordination, preparation, and reporting required for inspections varies widely. An inspection normally consists of three distinct parts; planning, engineering, and documentation. The planning phase results in the flight inspection plan.The engineering or equipment phase includes necessary tests to ensure the radar system performs to design specifications. Although this phase is primarily an AF engineering function, some tests may require a flight inspection aircraft. The tests required during the engineering phase are referenced in paragraph 215.31, Checklist, and paragraph 215.32, Detailed Procedures. The documentation or flight inspection portion determines if AT requirements are met and establishes a radar coverage baseline. AT requirements are outlined in the facility siting report and the inspection plan. The detailed flight inspection procedures are covered under paragraph 215.32.

b. Commissioning Inspections. The objective of the commissioning inspection is to evaluate system performance, determine and document the site coverage, and provide a baseline for the detection of a deterioration in equipment performance. Data obtained during this inspection will be used for daily comparison of facility performance, as well as future inspections. The commissioning is the most thorough inspection and requires a correspondingly detailed plan and report.

c. Periodic Inspections. FAA ASR's and military ASR's without surveillance approaches do not require a periodic flight inspection. ASR's which are operated by the military and have surveillance approaches require a periodic flight inspection of the surveillance approaches.

d. Special Inspections. Special inspections are conducted to fulfill a particular need and may be very limited in scope. The limited inspection may not require a formal written plan, and only a short inspection report. If equipment changes or modifications to commissioned facilities change the coverage pattern, document the changes in the inspection report. The new coverage pattern then becomes the basis for comparison during subsequent inspections. Coordination with appropriate military personnel is vital at joint-use sites. Special inspections include the following:

(1) Engineering Support. Engineering support is performed to help engineering and AT personnel determine if the radar meets equipment certification and operational requirements. This data may be used for commissioning purposes, provided no equipment modifications are made prior to the commissioning inspection. Requirements for specific checks will be determined by facilities maintenance personnel and need not conform to a specific format.

(2) Antenna Change. Paragraph 215.31, Checklist, identifies requirements for the installation of a new antenna of the same or different type. If there is a question concerning the characteristics or type of antenna being installed, the AF engineer in charge will determine which antenna change checklist applies. A flight inspection is not required following an antenna pedestal or rotary joint change, provided the ground measurements of the reflector position, feedhorn alignment, and antenna tilt of the replacement pedestal, are satisfactory. Refer to paragraphs 215.3206e(5) and (6) for antenna change procedures.

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c. Periodic Inspections. FAA ASR's and military ASR's without surveillance approaches do not require a periodic flight inspection. ASR's which are operated by the military and have surveillance approaches require a periodic flight inspection of the surveillance approaches.

d. Special Inspections. Special inspections are conducted to fulfill a particular need and may be very limited in scope. The limited inspection may not require a formal written plan, and only a short inspection report. If equipment changes or modifications to commissioned facilities change the coverage pattern, document the changes in the inspection report. The new coverage pattern then becomes the basis for comparison during subsequent inspections. Coordination with appropriate military personnel is vital at joint-use sites. Special inspections include the following:

(1) Engineering Support. Engineering support is performed to help engineering and AT personnel determine if the radar meets equipment certification and operational requirements. This data may be used for commissioning purposes, provided no equipment modifications are made prior to the commissioning inspection. Requirements for specific checks will be determined by facilities maintenance personnel and need not conform to a specific format.

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Figure 215-1

ANTENNA CHANGE CHECKLIST

	Para Ref 215.xxxx	Comm	Primary Same Type	Primary Diff Type	ATCRBS Same Type	ATCRBS Diff Type	Major Mods	FI Transponder TX Pwr	FI Transponder RX Sens
Orientation	.3201	X,1	X,1	X,1	X,1	X,1	X,1	Normal	LOW
Tilt	.3202	X,1	1	X,1	1	X,1	1	Normal	LOW
Primary Rdr Optim	.3203	1						Normal	LOW
ATCRBS Optim									
Power	.3212	X,2				X,2		Normal	LOW
SLS/ISLS	.3210	X,1				X,1		Normal	LOW
Modes/Codes	.3211	X,1						Normal	LOW
GTC/STC	.3213	X,1				X,1		Low Pwr	LOW
Vertical Coverage	.3204	X,2	1	X,2	1	X,2	1	Low Pwr	LOW
								Normal	LOW (Above 15,000 ft)
Horiz Screening	.3205	1						Normal	LOW
Airways/Route Coverage	.3206	X,2	1	1	1	1		Normal	LOW
Fix/Map Accuracy	.3207	X,1	1	1	1	1	1	Normal	LOW
Fixed Tgt Ident	.3208	X,1						Normal	LOW
Surveillance Apch	.3209	X,2	X,2	X,2				Normal	LOW
Communications	.3214	X,1						As requested	
Standby Equipt	.3215	X,1						As requested	
Standby Power	.3216	X,1						As requested	

NOTES:

X Denotes mandatory check; see text for approved procedure. All other checks are at engineering/maintenance/controller request.
1 May be accomplished by software analysis using targets of opportunity or radar data acquisition subsystems (RDAS).
2 Requires Flight Inspection aircraft for final setting.

215.32 Detailed Procedures.

a. General. Facilities maintenance personnel shall use operational displays for target grading and guidance information. Facilities maintenance personnel shall configure the radar in its lowest usable configuration (the traditional worst case configuration, all enhancements on, may degrade newer "smart" radars to the point that they become unusable). Data from the operational displays and automation diagnostic and analysis programs will determine if the system supports operational requirements. When using targets-of-opportunity, multiple target returns are required to ensure accuracy. Verify questionable accuracy with a flight inspection aircraft.

b. Evaluation ATCRBS and primary radar shall be evaluated simultaneously throughout the inspection whenever possible. If ATCRBS replies obscure the primary targets, the displayed ATCRBS should be offset slightly to allow evaluation of both replies.

c. Inspection Sequence. The engineer shall ensure the radar facility is operating according to design specifications before any inspection tests begin. The inspection should start with orientation, tilt, and an initial ATCRBS power setting. During installation, the antenna is normally set to the tilt recommended in the siting report and the azimuth is set to a prescribed reference. These settings should provide adequate accuracy for the initial tests. The initial ATCRBS power may be set to either a theoretical value or a setting that will interrogate aircraft at maximum radar range. After refining these preliminary settings and becoming confident in them, the engineer should use targets-of-opportunity to ensure that primary and secondary coverages are at least as good as that required in the overall quality test. Tests which can be completed without using a flight inspection aircraft should be conducted prior to the arrival of the flight inspection aircraft. At joint-use sites, inspection sequence may vary, in order to satisfy the requirements of all agencies concerned.

> **NOTE:** Parameter changes that occur during the flight inspection aircraft evaluation may require a repetition of previously conducted tests.

215.3201 Orientation.

a. Purpose. To verify the radar azimuth corresponds with a known azimuth position and shall be conducted with a flight inspection aircraft or ground check as listed under alternate procedure this section.

b. Approved Procedures.

(1) Fly inbound or outbound radially over a well-defined ground checkpoint or position the aircraft using AFIS. The altitude and distance of the checkpoint should be well inside the radar coverage limits.

(2) A radar PE, maintenance beacon, or MTI reflector of known location may be used to determine alignment of the radar azimuth in lieu of a flight inspection aircraft.

c. Evaluation. Compare the azimuth observed by the controller with the magnetic azimuth of the checkpoint.

215.3202 Tilt Verification

a. Purpose. To verify the primary and secondary radar antenna tilt settings are optimum and the mechanical antenna tilt indicators are accurate.

b. Approved Procedure. Facilities maintenance personnel shall direct the aircraft through the heaviest ground clutter within operational areas so the predetermined angle can be evaluated and adjustments made if required. If radar coverage is acceptable and the radar range is satisfactory, complete the vertical coverage check. Facilities maintenance personnel shall evaluate the antenna tilt angle during the vertical coverage profile. If parameters are not acceptable, it may be necessary to reestablish the antenna tilt angle. In this case, refly the vertical coverage profile using the new antenna tilt angle.

c. Evaluation. The tilt selection process considers the interaction of various radar parameters and the final radar system performance. The optimum tilt angle is a compromise between coverage (with/without MTI) over clutter and range coverage.

215.3203 Primary Radar Optimization

a. Purpose. To aid in maximizing the radar's potential. Adjustments in STC, beam gating, receiver sensitivity, pulse width, etc., may improve a radar's performance.

b. Approved Procedure. Facilities maintenance personnel will provide a detailed flight profile.

c. Evaluation. Facilities maintenance personnel will observe the target display and adjust the radar as necessary.

215.3204 Vertical Coverage

a. Purpose. To determine and document the coverage in the vertical plane of the primary and ATCRBS antenna patterns. Evaluate the inner and outer fringes on all primary and secondary radars.

b. Vertical Coverage Azimuth. Choose an azimuth from the radar antenna or coincident VOR/TACAN radial from the radar antenna which is free of clutter, dense traffic, heavy population areas, and interference created by line-of-site obstructions. Conduct the commissioning inspection and all subsequent inspections concerning facility performance, on the same azimuth for comparison purposes. For inspection at altitudes above flight inspection aircraft surface ceiling, Airway Facilities/Air Traffic has the option of using targets of opportunity/RDAS.

c. Configuration:

(1) Aircraft. The secondary radar portion of the vertical coverage check requires a calibrated transponder set in accordance with paragraph 215.22d. During the vertical coverage test, the aircraft transponder will be set at Lo Power and Normal Sense for checks at and below 15,000 feet. For tests above 15,000 feet, set the transponder for Normal Power and Low Sense.

(2) Radar. Facilities maintenance personnel shall determine the lowest usable radar configuration. Suggested configurations are as follows:

Antenna Polarization	Circular
Diplex Systems	Simplex mode
Integrators/Enhancers	OFF
Magnetron/Amplitron Systems	Amplitron (See Note)
Video Processor (military mobile radar)	OFF
ASR-9 Display Video	Uncorrelated
ARSR-3:	
Target Threshold:	91
MTI: I & Q	"I"

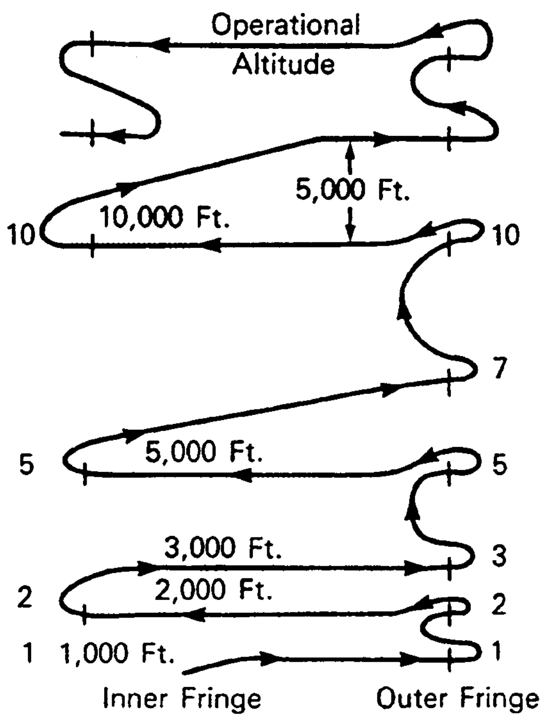
NOTE: At the request of engineering, conduct an additional vertical coverage check for the ARSR 1 & 2 with the amplitron OFF. It is not necessary to conduct the entire vertical coverage; only a spot check of altitudes and ranges, as specified by the engineer.

d. Approved Procedures. Determine the outer fringe coverage by evaluating tail-on targets and the inner fringe coverage by nose-on targets. When special requests are made by facilities maintenance personnel to evaluate target returns at the outer fringe with nose-on targets, clearly differentiate between nose-on and tail-on results on the flight inspection report. Aircraft reflective surfaces and transponder antenna radiation characteristics vary between inbound and outbound flight; consequently, differences in coverage can be expected. The flight inspector shall obtain the vertical coverage azimuth and highest operational altitude from the facilities maintenance personnel. Use map checkpoints, a NAVAID radial, AFIS, or radar vectors to remain on the vertical coverage azimuth. Fly all pattern altitudes as height above the radar antenna. The flight inspector must compute and fly absolute altitudes (corrected for pressure and temperature) above ground level.

(1) Commissioning Vertical Coverage Profile, ASR/ATCRBS. Refer to figure 215-2 and proceed as follows:

Figure 215-2

Commissioning--ASR/ATCRBS Vertical Coverage Profile



(a) Determine the inner fringe at 1,000 feet. Then fly outbound at 1,000 feet and establish the outer fringe.

(b) Climb to 2,000 feet and establish the outer fringe. Then proceed inbound at 2,000 feet and establish the inner fringe.

(c) Climb to 3,000 feet and establish the outer fringe.

(d) Climb to 5,000 feet and establish the outer fringe.

(e) Repeat the outer fringe check at 5,000 feet (or lower if necessary) to evaluate radar auxiliary functions such as linear polarization, pin diode, integrators, etc., on the primary and GTC/STC on the secondary radar. Linear polarization normally increases the usable distance, so this check should be performed at an altitude where the change can be observed. Most auxiliary functions produce a decrease in receiver sensitivity, thereby decreasing the usable distance. Conduct these tests by establishing the outer fringe with the function on, and then off, and noting the difference in usable distance.

(f) Return the equipment to its original inspection configuration and proceed inbound at 5,000 feet and establish the inner fringe.

(g) Climb to 7,000 feet and establish the outer fringe.

(h) Climb to 10,000 feet and establish the outer fringe. Then proceed inbound at 10,000 feet and establish the inner fringe.

(i) If the operational altitude is greater than 10,000 feet, check the outer fringe in 5,000 foot increments up to the operational altitude; e.g., if 17,000 feet, check the outer fringe at 15,000 and 17,000 feet, then proceed inbound at the operational altitude and establish the inner fringe. The aircraft transponder shall be set to normal power and low sense for checks above 15,000 feet. If satisfactory radar coverage is not maintained during this inbound run, conduct additional flights through the vertical coverage pattern and establish the maximum usable altitude.

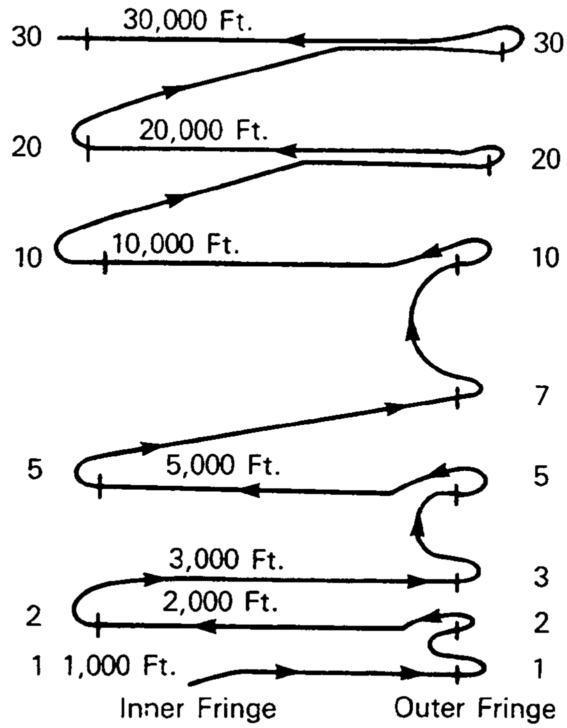
(j) Check the inner fringe at the altitudes used to establish the outer fringe stepping down in altitude to the 10,000-foot level.

NOTE: If the operational altitude is 10,000 feet or lower, do not inspect vertical coverage above this altitude unless requested.

(2) Commissioning Vertical Coverage Profile, ARSR/ATCRBS.

Figure 215-3

ARSR/ATCRBS Vertical Coverage Profile



(a) Complete steps (a) through (h) of the ASR commissioning requirements in paragraph 215.3204d(1).

(b) Climb to 20,000 feet and establish the outer fringe. Then proceed inbound at 20,000 feet and establish the inner fringe.

(c) Climb to 30,000 feet and establish the outer fringe.

(d) Repeat the outer fringe as required to conduct auxiliary functions tests.

(e) Then proceed inbound at 30,000 feet and establish the inner fringe.

(f) If operational or engineering requirements are greater than 30,000 feet or 30,000 feet conflicts with air traffic, climb to a mutually agreeable altitude (to a maximum of 35,000 feet) and establish the outer and inner fringes.

(3) Commissioning Inspection - Military BRITE/DBRITE Display. Inspect an ASR which has the sole function of providing a video source for a BRITE/DBRITE display to operational requirements or 4,000 feet/10 miles, whichever is greater.

(a) Determine the inner and outer fringes at every 1,000-foot level up to 4,000 feet or the operational altitude.

(b) No comparative equipment auxiliary function configuration checks are required.

(c) Target definition will be from the BRITE display.

(d) There are no periodic inspection requirements.

(4) Primary Radar Antenna Change. When the primary ASR or ARSR antenna is changed, fly the vertical coverage profile depicted in figure 215-4 or 215-5, as applicable.

(a) After determining the outer fringe at 5,000 feet, repeat the outer fringe check, as required, to evaluate auxiliary functions as requested by facilities maintenance personnel. Conduct the remainder of the coverage check in the original configuration.

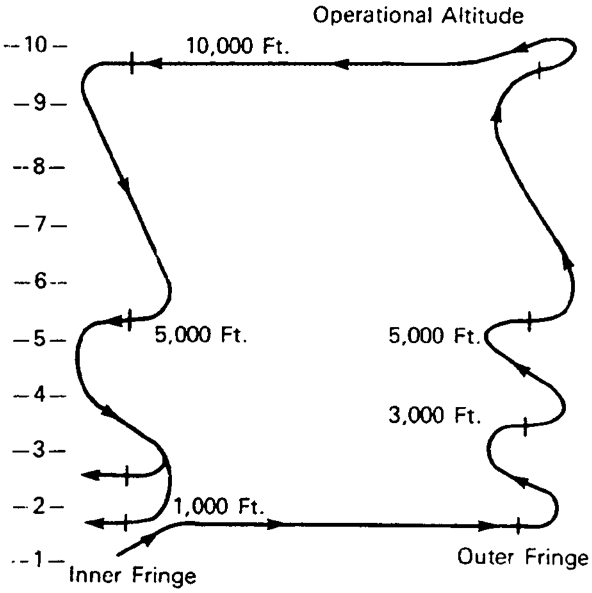
(b) Checks of additional facility equipment configurations and altitudes will be at the option of facilities maintenance personnel.

(5) ATCRBS Antenna Change. When replacing the antenna with the same type, all inspection requirements may be completed using targets-of-opportunity. When the antenna is replaced with a different type or targets-of-opportunity are not available, checklist requirements shall be completed using a flight inspection aircraft.

(a) Terminal Radar. Fly the profile for a primary radar antenna change as indicated in paragraph 215.3204d(1) and Figure 215-4.

Figure 215-4

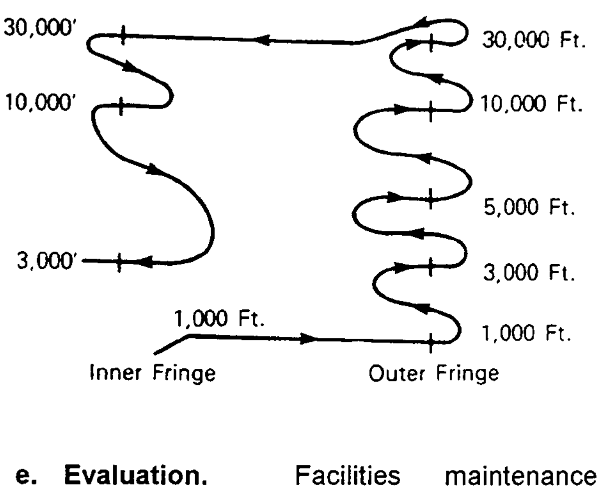
Antenna Change--ASR/ATCRBS



(b) En Route Radar. Fly the profile for a primary radar antenna change as indicated in paragraph 215.3204d(2) and figure 215-5.

Figure 215-5

Antenna Change--ARSR/ATCRBS



e. Evaluation. Facilities maintenance personnel shall record target strength as defined in paragraph 215.5a on each scan, aircraft position every five miles, and aircraft altitude for each fringe check and level run. Facilities maintenance personnel shall document results of the vertical coverage check using analysis/diagnostic programs (RDAS tools), when available, for inclusion in the facility report.

215.3205 Horizontal Screening

a. Purpose. To verify the indicated coverage on the horizontal screening charts. This test is optional depending upon operational requirements and ground evaluation tools available. After reviewing the results of the vertical coverage check and other data, engineering personnel will determine if the horizontal coverage check is required.

b. Approved Procedure. Fly an orbit at an altitude and distance which corresponds to the lowest screening angle at which coverage is expected. Do not use an orbit radius of less than ten miles. AFIS, DME, or vectors provided by the controller may be used to maintain the orbit. The Flight Inspector shall select "Normal" on the aircraft transponder. MTI, if used, should be gated to a range inside the orbit radius, except where ground clutter obscures the targets unless MTI is used. If MTI is gated outside of the orbit, the radius of the orbit must be constantly changed to avoid target cancellation due to tangential blind speed. For example, vary the distance on a 12-mile orbit between 10 and 14 miles, flying oblique straight courses between the 10-mile and 14-mile orbits, so as to average a 12-mile orbital distance.

c. Evaluation. Facilities maintenance personnel shall record target strength, azimuth and distance every scan. They shall determine if the coverage supports operational requirements.

215.3206 Airway/Route Coverage

a. Purpose. To document coverage along routes and airways, required by AT. Facilities maintenance personnel shall determine the extent of these evaluations which determine the overall radar facility coverage. Areas of intense clutter, poor target returns, or other potential problems identified in the inspection plan may be further evaluated to determine actual facility coverage. This check may be accomplished using targets-of-opportunity or flight inspection aircraft.

b. Approved Procedures.

(1) When a flight inspection aircraft is used, the flight inspector shall select "Normal Power" on the transponder. Facilities maintenance personnel shall configure the primary radar in "circular polarization". The altitudes at which satisfactory radar coverage exists will be determined by flying the minimum altitude (not lower than MOCA) on airway centerline. The terminal arrival and departure routes and other areas of interest identified in the inspection plan will be flown at MOCA. Maintain course guidance by reference to AFIS, ground checkpoints, NAVAID signals, or radar vectors. Coverage verification using linear polarization may be checked at the discretion of the test engineer or, if a joint use site, by the DOD agency.

(2) Targets-of-Opportunity. Targets may consist of one or an assortment of aircraft returns on a particular airway, route or terminal radial. Targets used must be mode-C equipped so altitude information can be obtained. Scoring may be accomplished by either RDAS tools or manually. RDAS may be used to evaluate the track information of a selected (beacon code) target.

c. Evaluation. Facilities maintenance personnel shall determine if the facility coverage meets operational requirements.

215.3207 Fix/Map Accuracy.

a. Purpose. To verify the accuracy of all airways, routes, fixes, and runway centerlines on the video map display. Replacement map overlays, video maps, or digitally-generated maps do not require a flight inspection if facilities maintenance personnel can determine, using targets-of-opportunity, that the new map is accurate.

b. Approved Procedure. The flight inspector shall fly the minimum altitude where satisfactory radar coverage exists using NAVAID guidance, ground checkpoints, or AFIS to identify the airway, route, or fix. The procedure is the same whether using a flight inspection aircraft or targets-of-opportunity; facilities maintenance personnel compare reported aircraft position relative to the airway, route, or fix with the video map presentation. Similarly, verify runway centerline to video map alignment by observing landing and departing aircraft.

c. Evaluation. Compute the distance between the airway, route or fix, and the aircraft position, and apply the appropriate tolerance.

215.3208 Fixed Target Identification.

a. Purpose. To identify prominent, primary broadband targets used for range and azimuth accuracy checks when they cannot be identified by other means. This check may be accomplished using targets-of-opportunity or flight inspection aircraft.

b. Approved Procedure. Facilities maintenance personnel will select identifiable features from a comparison of the ground clutter return and geographic maps (islands, mountain peaks, towers, etc.). They should direct the pilot to the PE return. If the pilot can identify and describe the ground target, and the target is a permanent feature, record the PE in the inspection report.

c. Evaluation. The pilot shall identify and record a description of the PE for inclusion in the inspection report.

215.3209 Surveillance Approaches.

a. Purpose. All ASR approaches must be checked for accuracy and coverage by a flight inspection aircraft during commissioning inspections or any time a new approach procedure is developed. Additionally, military ASR approaches must be checked on a periodic basis. Surveillance approaches shall be evaluated using surveillance type radar scopes. Conducting an ASR approach on a PAR display is not acceptable for flight inspection purposes. ASR approaches are not authorized using ATCRBS only, and the ATCRBS display should be offset.

(1) Approach to a Runway. The approach course shall coincide with the runway centerline extended and shall meet accuracy and coverage tolerances.

(2) Approach to an Airport. The approach course shall be aligned to the MAP as determined by procedures and facilities maintenance personnel. Helicopter-only final approach courses may be established to a MAP no farther than 2,600 feet from the center of the landing area.

b. Approved Procedure. The controller shall provide vectors for a 10-mile ASR final approach. The flight inspector shall fly at MVA until reaching the final approach segment. The final approach segment shall be flown 100 feet below all mandatory altitudes. The flight inspector shall evaluate the approach procedure, evaluate the aircraft position relative to the runway centerline extended/airport, and determine if a landing can be made without excessive maneuvering.

c. Evaluation. ASR approaches shall meet flight inspection tolerances or be canceled by appropriate NOTAM action. The cancellation of an ASR approach does not constitute a restriction on the radar facility. When MTI is required for an ASR approach, information shall be documented on the flight inspection report. The use of MTI does not constitute a facility restriction; however, ASR approaches which require MTI are NOT authorized when this feature is inoperative.

215.3210 Side-Lobe Suppression.

a. Purpose. To set transmitter power levels in the beacon SLS or ISLS antenna elements. The use of SLS/ISLS improves beacon performance, reducing or eliminating ring-around caused by the side lobes of the antenna pattern. ISLS also reduces false targets which are normally caused by close, vertical reflecting surfaces. This check may be accomplished using targets of opportunity or flight inspection aircraft.

b. Approved Procedure. Facilities maintenance personnel shall select azimuths to be checked in areas where side lobe problems have occurred in the past. Fly these radials at 1,000 feet above the radar site elevation to the coverage limits (normally line-of-sight). Facilities maintenance personnel shall adjust the SLS or ISLS power levels while observing beacon inner-range coverage. The power levels shall be adjusted for minimum ring-around and false target returns. After making final adjustments, ensure that inner range coverage is still satisfactory.

c. Evaluation. Facilities maintenance personnel shall observe the display for decreased performance due to SLS/ISLS.

215.3211 ATCRBS Modes and Codes

a. Purpose: To verify the proper decoding of ATCRBS reply pulses. Facilities maintenance personnel shall ensure that all modes and codes are verified by equipment test procedures before requesting flight inspection. Codes 7500, 7600, and 7700 should not be used due to the possibility of alarming other facilities.

b. Approved Procedure. Facilities maintenance personnel shall monitor the flight inspection aircraft transponder replies throughout the vertical coverage, airway, route, and terminal checks to verify correct altitude readout. During these tests, facilities maintenance personnel should request the flight inspection aircraft use different modes or codes to sample various mode and code trains.

c. Evaluation. Facilities maintenance personnel shall ensure the displayed transponder reading agrees with the aircraft transponder setting.

215.3212 ATCRBS Power Optimization

a. Purpose. To reduce over-interrogation, over-suppression, fruit, and false targets caused by reflections. Optimum ATCRBS power shall be the minimum ATCRBS power to meet operational requirements.

b. Approved Procedures.

(1) The minimum ATCRBS power shall be set during ground testing, prior to flight inspection. ATCRBS performance is then evaluated by facilities maintenance personnel during the vertical coverage, route, and fix checks.

(2) The following checks shall be conducted using a flight inspection aircraft equipped with a calibrated transponder, set at "Low Sens." The aircraft shall be positioned to fly an arc in the vicinity of the vertical coverage radial at maximum distance. The aircraft altitude shall be 10,000 feet for ASR's and 30,000 feet for ARSR's, or as close to these altitudes as operational conditions allow. The beacon transmitter power shall be adjusted to the minimum value that produces a usable beacon return. During this check, ensure that the aircraft transponder antenna is not shielded by aircraft.

The vertical coverage shall be checked using this power level and the beacon commissioned at this power level, plus 1 dB.

c. Evaluation. Facilities maintenance personnel shall observe ATCRBS performance during the vertical coverage, route, and fix checks and, if required, during the alternate procedure method.

> **NOTE:** Although this test may be accomplished during the vertical coverage check, any changes made in beacon power, as a result of this test, will invalidate any portion of the vertical coverage profile checked previously.

215.3213 ATCRBS GTC/STC Evaluation.

a. Purpose. To evaluate the ATCRBS GTC/STC setting. It shall be adjusted prior to the flight inspection and confirmed during the vertical coverage checks. GTC/STC reduces the interrogator receiver gain, as the range to the station reduces, thereby reducing ring-around and false targets.

b. Approved Procedures.

(1) Facilities maintenance personnel shall observe the flight inspection aircraft target (aircraft transponder switch set at "Low Sens" position) for ring-around, during the vertical coverage checks. Ring-around is an indication the GTC/STC is improperly adjusted.

(2) If false targets and/or ring-around persists, conduct a special target scoring check conducted solely for setting GTC/STC. This test requires a flight inspection aircraft with a calibrated transponder set on "Normal Sense" and the antenna attenuator switch set on "Lo/Lo" or "Low Power". Position the aircraft on the vertical coverage radial, either inbound or outbound, at 10,000 feet AGL for ASR's and at 30,000 feet AGL for ARSR's or as close to these altitudes as operational conditions allow. Facilities maintenance personnel shall examine the received beacon signal during the entire radial (fringe to fringe). Correct GTC/STC setting is indicated by a fairly constant signal level over the entire radial.

c. Evaluation. Facilities maintenance personnel shall observe the display for false ATCRB's targets or ring-around.

215.3214 Communications. The purpose of this check is to evaluate VHF/UHF communications capability within the radar coverage area. The flight inspector shall check communications in accordance with Section 211, concurrent with the radar inspection.

215.3215 Standby Equipment. The purpose of this check is to evaluate the performance of standby equipment, and may be accomplished during pre-inspection testing using targets-of-opportunity. If standby equipment is available but not working, the flight inspector must be notified (see paragraph 106.32). Some radar installations are engineered to meet reliability requirements by the use of redundant parallel units, instead of standby transmitters. Conduct flight inspection of these facilities while the system is operating in parallel. A separate check of each channel is not required. Some replacement radar units are colocated in the building with the primary radar and share the same waveguide and antenna during installation and checkout. In this case, the standby transmitter cannot be placed in operation without an extended facility shutdown. The pre-inspection testing of these systems shall thoroughly test all redundant and standby units to ensure they meet or exceed tolerances established on the flight inspected channel. A standby antenna (duplicate) may be installed at selected locations to provide continued radar service, in the event of antenna failure. The commissioning requirements for a standby antenna will be completed using the antenna change checklist.

215.3216 Standby Power. See paragraph 106.43. The purpose of this check is to evaluate radar performance on standby (engine generator) power and shall be conducted during pre-inspection testing. Results are satisfactory when the engine generator monitor equipment detects a power failure, starts the engine, and switches to the engine power without manual intervention. Conduct this test with a simulated power failure by manually switching out the incoming commercial power.

215.4 Analysis.

a. Testing Precautions. Radar inspections should not be attempted during heavy precipitation, temperature inversions, or other atmospheric conditions which change the coverage from normal. Whenever a system parameter does not meet tolerances and cannot be adjusted within a reasonable length of time, discontinue the flight inspection until the discrepancy is resolved. This does not preclude the continuation of tests in an effort to resolve the problems.

b. Evaluation. Usable radar coverage does not mean a usable target return on every scan at every azimuth and all usable altitudes. Missed targets can be caused by antenna lobing, line-of-sight, aircraft attitude, or antenna tilt. Therefore, isolated or non-recurring target misses are to be expected. If three or more consecutive misses are experienced, determine if a hole exists in the radiation pattern and determine its size. If holes or poor coverage are discovered, they must be evaluated to determine the effect on the operational requirements.

c. Probing. Holes in radar coverage are probed in a manner similar to VOR to TACAN. The following procedure may be used as a guide:

(1) Horizontal. Fly through the area of the suspected hole to determine the inner and outer boundaries. Vary the aircraft position every 10 degrees of radar azimuth until the lateral limits are established.

(2) Vertical. Fly through the center of the pattern established in the horizontal probing procedure at 1,000-foot increments to determine the upper and lower limits of the hole.

Figure 215.5

Tolerances

Parameter	Reference	Tolerance/Limit
Target Strengths		
Broadband/Reconstituted		
3--usable		Target leaves trail or persists from scan-to-scan without trail.
2--usable		Target shows each scan, remains on the display for at least 1/3 of the scan.
1--unusable		Weak target, barely visible, possible miss.
0--unusable		No visible target.
Narrowband		
1--usable		Visible target, satisfactory for ATC purposes.
0--unusable		No visible target, unsatisfactory for ATC
Usable Target		Target which is not missed/ unusable on three or more consecutive scans.
Orientation Maximum azimuth difference between actual and indicated for broadband and narrowband radar systems	.3201	$\pm 2^{\circ}$
Tilt	.3202	No airborne tolerance.

Parameter	Reference	Tolerance/Limit
Coverage		
Vertical - from inner to outer fringe	.3204	Meets operational requirements at all altitudes.
Horizontal	.3205	No tolerance.
Approaches, airways, arrival and departure routes, and fixes route/procedure	.3206	A usable target return shall be maintained along the entire route or throughout the procedure.
Accuracy		
Fix/map	.3207	Within 3% of aircraft to antenna distance or 500' (1,000' for ATCRBS), whichever is greater.
Approaches	.3209	
Straight-in		Within 500' of runway edge at MAP.
Circling		Within a radius of the MAP which is 3% of the aircraft to the antenna distance or 500', whichever is greater.
Altitude Readout	.3211	±125' of altitude displayed in the cockpit relative to 29.92 in Hg.
ATCRBS Power	.3212	No tolerance.
GTC/STC	.3213	No tolerance.
Communications	Section 211	See paragraph 211.5
Standby Equipment .3215		Meet same tolerances as main (dual channel) equipment. See paragraph 106.32.
Standby Power	.3216	See paragraph 106.43.

215.6 Documentation. The AF regional office of concern, or military equivalent, shall compile and complete the facility inspection performance report. It shall be a detailed accounting of all coverage data obtained using ground testing data, flight inspection aircraft, targets-of-opportunity, RDAS tools, and all flight inspection report information. The report submitted by the flight inspector shall contain only that information evaluated by the flight inspection crew. At joint use sites, the RADES shall publish a separate report for each joint evaluation.

215.7 Facility Classification. The facility inspection performance report shall reflect a facility classification determined by the facility engineer in charge (or military equivalent). The flight inspection report shall reflect a facility classification jointly determined by the flight inspector and facilities maintenance personnel. Inaccuracies beyond established tolerances in range and azimuth for fix/map targets or surveillance approaches, will be the basis for the flight inspector to restrict the system or to request that it be removed from service until the condition is corrected.

Parameter	Reference	Tolerance/Limit
Coverage		
Vertical - from inner to outer fringe	.3204	Meets operational requirements at all altitudes.
Horizontal	.3205	No tolerance.
Approaches, airways, arrival and departure routes, and fixes route/procedure	.3206	A usable target return shall be maintained along the entire route or throughout the procedure.
Accuracy		
Fix/map	.3207	Within 3% of aircraft to antenna distance or 500' (1,000' for ATCRBS), whichever is greater.
Approaches	.3209	
Straight-in		Within 500' of runway edge at MAP.
Circling		Within a radius of the MAP which is 3% of the aircraft to the antenna distance or 500', whichever is greater.
Altitude Readout	.3211	±125' of altitude displayed in the cockpit relative to 29.92 in Hg.
ATCRBS Power	.3212	No tolerance.
GTC/STC	.3213	No tolerance.
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SECTION 216. PRECISION APPROACH RADAR (PAR)

TABLE OF CONTENTS

SECTION 216. PRECISION APPROACH RADAR (PAR)

216.1 INTRODUCTION

a. This section provides instructions and performance criteria for certifying precision approach radars. The PAR is designed to provide an approach path for precise alignment and descent guidance to an aircraft on final approach to a specific runway through interpretation and oral instructions of a ground based controller.

b. PAR's provide a very high degree of resolution in terms of range, azimuth and elevation by radiating a narrow pulse and beam width. The pulsed beams are radiated along the predetermined descent path for an approximate range of 10 to 20 miles, and covers a sector of 20° in azimuth and up to 15° in elevation. Target information is displayed on an azimuth and elevation display. The displays must provide accurate information regarding an aircraft's range, azimuth, and elevation angle.

c. New Generation PAR's have been developed which provide all of these features with the addition of a selectable glidepath angle and the introduction of a computer generated target.

216.2 PREFLIGHT REQUIREMENTS

216.21 Facilities Maintenance Personnel. Prepare for flight inspection in accordance with the procedures outlined in Section 106.

216.22 Flight Personnel. The flight inspector will be in complete charge of the flight inspection. Flight personnel will prepare for the inspection in accordance with the procedure outlined in Section 106.

216.23 Special Equipment Requirements. Aircraft with altimeters calibrated according to FAR 43, appendix E, and FAR 91.170 or military specifications may be used for PAR flight checks. Theodolite or AFIS is required as follows:

a. During commissioning and/or after accident inspection of the glidepath angle and the lower safe angle.

b. Any time that more definitive analysis is required (e.g., engineering, research, development, etc.) of either the glidepath or the course azimuth.

216.24 Theodolite Procedures. The RTT or theodolite will be positioned as follows:

a. Glidepath Angle

(1) Place the theodolite as close to the runway as possible, forward of the RPI, to minimize or eliminate elevation differences between RPI (touchdown) and theodolite locations. The touchdown reflector is usually abeam the RPI, but not always. Therefore, the facility data sheet must be checked to establish the exact RPI location. Aircraft operations will dictate how close to the runway the theodolite can be located.

NOTE: During the commissioning inspection of a new or relocated PAR, it is imperative that flight inspection personnel coordinate closely with the TERPS specialist and installation personnel to locate the predetermined RPI.

(2) The distance the theodolite must be moved forward of the RPI to have the eye-piece aligned on the glidepath angle can be computed in the same manner as solving for ILS glidepath angles or tapeline altitudes. For example, a theodolite with the eye-piece set at 5 feet at a glidepath angle of 3.0° would be positioned 95.4 feet forward of the RPI.

b. Lower Safe Angle

(1) If the lower safe angle emanates from the same RPI as the glidepath, the theodolite position will be the position determined for the glidepath.

(2) If the lower safe angle emanates from a point other than the RPI for the glidepath, the theodolite will be relocated. Position and align the theodolite in accordance with instructions for glidepath angle using the lower safe angle RPI.

c. Course Alignment. Position the theodolite on runway centerline to evaluate course alignment at the runway threshold. Aircraft operations will dictate theodolite placement.

216.3 Flight Inspection Procedures. The flight inspection procedure for a PAR is divided into three parts:

a. Azimuth radar

b. Elevation radar

c. Overall system and controller performance (includes feature comparisons).

Commissioning inspections will provide engineering, maintenance, and operations personnel with sufficient data to determine system performance. Data obtained from the commissioning inspection will be the basis for the comparison of facility performance on subsequent inspections. Requirements for special checks will be determined by engineering, maintenance, and operations personnel, and will be conducted as specified in Section 104.

216.31 Checklist. This checklist is solely for clarity of presentation and does not indicate any required sequence of events. Frequently the flight inspector will be able to combine several of these checks and obtain the required information in a very short time. At locations where approaches to more than one runway are provided, checks will be accomplished for each runway on commissioning inspections, and for each runway at least once annually thereafter on periodic inspections.

Where mobile equipment is used, check each runway and each location on the commissioning inspection, and each approach at least once annually thereafter. Engineering, maintenance, or operations personnel may require additional data not provided from these checks. When a reasonable request for other checks is made, the flight inspector will cooperate in obtaining the desired information.

Type Check	Reference Paragraph	C	P
a. Course Alignment (Azimuth)	216.3201	X	X
b. Course Deviation Accuracy	216.3202	X	X
c. Range Accuracy (Azimuth & Elevation)	216.3203	X	X
d. Coverage (Azimuth & Elevation)	216.3204	X	X
e. Coverage (Lateral)	216.32041	(1)	(1)
f. MTI (Azimuth & Elevation)	216.3205	X	(1)
g. Glidepath Alignment	216.3206	X	X
h. PAR/ILS Comparison	216.3207	X	X
i. Lower Safe Limit Alignment	216.3208	X	X
j. Approach Lights	216.3209	X	X
k. Communications	216.3210	X	X
l. Standby Equipment	216.3211	X	(2)
m. Standby Power	216.3212	X	(3)

NOTES:

(1) Perform check when requested by engineering/maintenance.

(2) See paragraph 106.42.

(3) See paragraph 106.43.

216.311 Requirements for PAR Using Computer Generated Targets. PAR's which use a computer generated target, such as the GPN-22 and TPN-19, have some unique requirements. During the initial commissioning inspection or to commission new primary and/or backup data bases, the following procedures will be used.

Type Inspection

C	P	Data base Change	Run	Configuration
X	X	X	1	"A" cursor, primary data base using track mode-normal, acquisition (ACQ)-automatic, FTC-on, MTI-coherent.
X		X,1	2	"A" cursor, primary data base using track mode-backup, ACQ-off (scan only), FTC-off, MTI non-coherent.
X			3	"A" cursor, backup data base, using the same features as run 1.
X			4	"B" cursor, backup data base, using the same features as run 1.
X	X	X	5	"B" cursor, primary data base using the same features as run 1.

NOTES:

1. Each data base requires a flight inspection prior to operational use in order to verify that the data base data can be loaded into the PAR computer and that the data produces the correct results. For a data base change inspection, run 2 is required ONLY when the data base is of a different version. If the new data base is of the same version as the data base being replaced, then runs 1 and 5 (normal periodic requirements) shall suffice.

2. Establish coverage limits during commissioning (or at maintenance request) by flying a 20-mile final approach; thereafter, controller/maintenance personnel shall monitor coverage on a daily basis using targets of opportunity.

3. Evaluate the operation on standby power during any of runs 1, 3, 4, or 5.

4. If one reference reflector and a common glidepath angle are used for parallel runways, only five runs are required for commissioning two data bases. Fly runs 1, 2, and 3 on the left runway, runs 4 and 5 on the right runway (1, 4, and 5 on the right runway if reflectors and/or angles are different), and reverse the order for opposite end.

For a single runway operation, reverse the data base sequence on the opposite end approach; i.e., fly run 1 on the backup data base, etc.

5. Commissioning requirements for standby equipment (consisting of a complete separate channel) can be completed by flying runs 1, 2, and 5 to any one of the runways served. If standby equipment is only a separate transmitter, fly run 1 from 20 miles to satisfy commissioning requirements.

On periodic inspections, check the channel that is operational; however, check each channel at least annually. Do not change channels during a run.

6. All other inspection requirements common to all PAR's also apply (see paragraph 216.31).

7. Document the following information for commissioning inspections and equipment/data base changes:

a. Transmitter power.

b. Receiver sensitivity in normal, coherent MTI, and non-coherent MTI.

c. Data base type, part, serial, and version numbers.

d. Clutter reject if required for approaches.

e. Digital MTI base line limiting settings

f. Usable radar range on 20-mile radar.

8. Due to system improvements, some features listed may not be available or controller selectable.

The following checklist shall be used to flight inspect AN/TPN-22 computer-generated PAR's.

C	P	Run	Configuration
X	X	1	"A" Cursor Auto-Mode (Note 1)
X		2	"B" Cursor Auto-Mode
X		3	"A" Cursor Manual-Mode (Note 2)
X	X	4	"B" Cursor Manual Mode

NOTES:

1. Controllers shall configure the Auto-Mode as follows: Load the PAR Program, OPS software, and System Initialization (SI) data and configure the Control and Status Panel per Table 1.

2. Controllers shall configure Manual-Mode as follows: Erase the OPS software and SI data, enter the basic SI data into the FC basic mode, and configure the Control and Status Panel per Table 1.

3. Standby power should be performed on the last run due to the extensive time required to reload the software and data.

4. All other inspection requirements common to all PARs also apply. See para 216.31.

5. Document the following information for commissioning inspections and hardware, software, or firmware changes.

(a) Transmitter output power
(b) Receiver sensitivity
(c) Program name, part, version, serial number, and build date
(d) Usable radar range

Sample program inventory sheet:

PROGRAM NAME	PART #	VERSION #	SERIAL #	BUILD DATE
PAR PROGRAM	N/A	V5R6	102	1/18/94
PAR PROGRAM	N/A	V5R6	103	1/18/94
CCS OPS SOFTWARE	111440	L-4	1000	7/25/94
CCS OPS SOFTWARE	111440	L-4	1001	7/25/94
CCS OPS SOFTWARE	111440	L-4	1002	7/25/94
CCS OPS SOFTWARE	111440	L-4	1003	7/25/94
CCS OPS SOFTWARE	111440	L-4	1004	7/25/94
CCS OPS SOFTWARE	111440	L-4	1005	7/25/94
CCS OPS SOFTWARE	111440	L-4	1006	7/25/94
CCS OPS SOFTWARE	111440	L-4	1007	7/25/94
CCS OPS SOFTWARE	111440	L-4	1008	7/25/94
CCS OPS SOFTWARE	111440	L-4	1009	7/25/94
PDS NVS FIRMWARE	111420	A-4	N/A	6/17/90
S.I. DATA	N/A	N/A	N/A	11/16/95
S.I. DATA	N/A	N/A	N/A	11/16/95

TABLE 1
Auto/Manual Mode Configuration

Button/Group	AUTO-MODE	MANUAL MODE
RCVR IF AMP		
AUTO	ON	ON
MANUAL	OFF	OFF
MTI GROUP		
MTI	ON	ON
7 DEGREE WEDGE	OFF	OFF
VELOCITY OFFSET	OFF	OFF
CFAR GROUP		
CFAR	ON	ON
AZIMUTH SECTOR GROUP		
20 DEGREE	OFF	OFF
30 DEGREE	OFF	OFF
46 DEGREE	ON	ON
ALS PAR MODES GROUP		
AUTO	ON	OFF
MANUAL	OFF	ON

216.32 Detailed Procedures

a. **General.** The basic method for checking a PAR is to have the controller vector the aircraft and provide guidance instructions to the flight inspector for evaluation of the facility.

b. **Maintenance/engineering personnel** in cooperation with operations personnel will spot check all features available on the PAR and advise the flight inspector if any of these features are not available or are unusable. These features include STC, FTC, and CP. On computer-generated radars, additional features include: non-coherent MTI (rain reject), ACQ (high and low), track mode (normal and backup), STC (high and low), and power (high and low). PAR checks will be made using circular polarization (CP) if available, and spot checks of the facility will be made using linear polarization. On some computer generated radars, CP is a fixed feature and is used at all times.

c. **Operational scopes will be used** on all flight checks for target grading and guidance information. Data taken from the operational scopes shall determine whether or not the facility meets the prescribed tolerances.

d. **Suitability and approval of approach procedures** previously developed by the procedures specialist are based on the flight check of the particular facility.

216.3201 Course Alignment (Azimuth). Any of the following methods may be used:

a. **Visual Method.** To check for course alignment, proceed in-bound at pattern/intercept altitude from approximately 10 to 12 miles from the runway and, when on-course and path, descend at a normal glidepath angle with the final controller furnishing information to enable the flight inspector to fly on the centerline azimuth. This information is to be given as "left," "right," or "on-course." Range should be given at least every mile. The flight inspector will determine, by visual reference to the runway, if the centerline is straight and if it coincides with the runway centerline extended.

b. **Theodolite Method.** At some locations, it may be necessary to use a theodolite to supplement the pilot's observations, especially when the runway is extremely wide or poorly defined by surrounding terrain. Proceed in-bound at pattern/intercept altitude from 10 to 12 miles from the field. Have the final controller furnish information as to the aircraft's position relative to runway centerline. The theodolite operator will continuously track the aircraft and inform the pilot of the aircraft position relative to runway centerline.

216.3202 Course Deviation Accuracy. While flying inbound on runway centerline extended, deviations to the right or left of centerline should be made with attention directed as to how far the aircraft must move off centerline before the controller notices movement. The controller needs only to state - slightly left (or right) of centerline.

216.3203 Range Accuracy. Check the accuracy of the range information, both video and fixed, by comparing the range information obtained from the radar scope with that obtained from a large scale map while over selected checkpoints or by comparison with DME. Checkpoints such as the outer marker or VOR are excellent; however, any well surveyed checkpoint is satisfactory, provided its distance from the field can be established. All ranges are measured in nautical miles from touchdown. In areas where there are no ground checkpoints or good electronic means of accurately measuring distance from the field, such as DME, this check may be omitted. Normally, two checkpoints, one at from 5 to 10 miles and one at 1/2 mile, are sufficient for checking range accuracy. Range accuracy checks of azimuth and elevation radar normally will be made simultaneously. (See paragraph 216.3204, Note.)

216.3204 Usable Distance. The check for usable distance or maximum range, may be made while proceeding in-bound from the limit of the radar coverage during the course alignment check by having the controller give the mileage when the aircraft is first displayed. The new radars have ranges of 15 to 20 miles, but because of small aircraft size, less coverage can be expected. Azimuth and elevation coverage can be checked simultaneously. Coverage of those PAR's which have coverage capabilities beyond 10 NM should be checked at the minimum vectoring altitude to the coverage capabilities of the radar. Coverage should be checked using alternately normal and MTI radar. Periodic coverage checks need to be made only in the area of operational use.

NOTE: Mileage information given by the radar operator should be the mileage from the touchdown point to the target aircraft. In case erroneous mileage information is given, the flight inspector should inquire if the range information obtained from the scope has been corrected to compensate for the distance from the antenna to the RPI (touchdown point).

216.32041 Coverage (Lateral). The lateral coverage of the PAR may be determined by flying perpendicular to the course. The aircraft should be AFIS equipped or a theodolite must be used. Altitude and distance will be determined by engineering/maintenance personnel. The controller will indicate when he/she obtains and loses radar contact. The AFIS or theodolite will be used to determine the angular coverage of the radar left and right of the course.

216.3205 Moving Target Indicator (MTI). Blind speeds for PAR systems are usually quite high due to the high pulse repetition frequency (PRF) required for good target definition. It may be quite difficult to perform an MTI check with certain types of small aircraft due to speed limitations. This check can be omitted if the speed range required is impossible to attain. The check can be performed at a later date when a faster aircraft is available. An airspeed notch of as much as plus or minus 20 knots may exist around the computed blind speed.

a. During the commissioning inspection, the MTI feature will be checked to determine if there are any blind speeds at which it is impossible to maintain continuous radar contact. On subsequent inspections, MTI needs to be checked only when requested by maintenance or operations. Maintenance personnel will provide the precomputed blind speed for the radar. Determine the airspeed which will give the required ground speed. Fly in-bound from approximately 10 miles (ensure that MTI is gated beyond 10 miles) while varying the air speed slightly above and below the previously computed airspeed. Note the speed range within which a reduction of target brilliance occurs. Close coordination between the controller and the flight inspector is necessary to determine the speed at which MTI causes the greatest effect.

b. When MTI is required on the final approach, this information shall be noted on the flight inspection report. The requirements for MTI do not constitute a facility restriction. Both azimuth and elevation MTI normally will be checked at the same time.

c. On radars with computer generated displays, the normal mode of operation is to use the synthetically generated symbols for approaches. The normal radar (scan) mode must be checked to determine its usability• for approaches. If unusable for approaches, determine the inner limit of usability so that the feature can be used for control and traffic information outside of that point. If the scan mode is not usable for approaches, it will not cause a facility restriction but will be documented in the remarks.

216.3206 Glidepath Alignment. During the glidepath alignment check, it is necessary to determine the glidepath angle and the straightness of the glidepath centerline (see paragraph 216.5f(1)). Some new military PAR's have the capability to provide controller selected multiple glidepaths. For these radars, evaluate the lowest angle to be used, based on adequate obstacle clearance or operational requirements, whichever is higher.

a. AFIS Methods. PAR glide slope angle may be determined by AFIS.

b. Theodolite Method. Position the theodolite according to instructions in paragraph 216.24. Communications on a common frequency are essential for the theodolite operator, final controller, and flight inspector. After communications have been established at all three locations, the aircraft should proceed in-bound from a point approximately 12 miles from touchdown and at the pattern altitude until the final controller advises that the aircraft is on the glidepath. A descent is then commenced, maintaining the aircraft as nearly on the centerlineor glidepath as possible by using the information furnished by the controller.

The pilot should maintain as constant an attitude as possible throughout the approach. Information should be given in terms of "above," "below," or "on glidepath." The theodolite operator will track the aircraft from the start of the in-bound run, maintaining the horizontal cross-hair exactly on the aircraft as it descends on the glidepath. As the aircraft proceeds in-bound, the theodolite operator should listen carefully to the glidepath information issued by the controller and have an assistant record the angle each time the controller calls the aircraft "on glidepath." Do not record calls taken inside of decision height. These angle readings should then be averaged to determine the actual glidepath angle.

c. Precision Range Mark Method. When it is impractical to check the glidepath alignment using the above methods, it is permissible to use the radar to determine the distance of the aircraft from the touchdown point. Obviously, any range errors present in the PAR will cause a corresponding error when measuring the glide slope angle. When making this check, calculate the altitude for the published/desired glidepath angle at the 6-, 5-, 4-, 3-, 2-, and 1-mile range marks. Instruct the PAR controller to give precise "on path" calls and the precise point at which the radar return crosses the range marks. By comparing the actual aircraft altitude at the exact point on glidepath with the calculated altitude, it can be determined that the glidepath is at the published/desired angle. Although there is a small amount of altimeter lag when proceeding down the glidepath using this method, it is negligible and can be disregarded. The straightness of the glidepath can be ascertained concurrently with the alignment check.

An alternative method is to fly a descending run on the glidepath and note the difference in altitude between range marks. It is necessary that the controller provide range information each time a path call is given. The glidepath can then be determined as indicated in the formula:

$$G.P.A. = \frac{A1 - A2}{106 \times D}$$

A1 = Indicated altitude at first on-path call in feet.

A2 = Indicated altitude at second on-path call in feet.

D = Distance between on-path calls in nautical miles.

216.32061 Application of Angle Tolerances. Prior to the commissioning inspection of PAR's, operational personnel must determine the "desired" angle to which the PAR is to be commissioned. This angle is determined by obstacle clearance criteria and operational use requirements. Design limitations of PAR elevation systems make it impractical to require the measured angle be less than one-tenth degree from this desired angle. Angles which are found to be more than one-tenth degree from the computed/programmed angle are indicative of faulty equipment or incorrect computations and should normally be corrected. The obstacle clearance criteria allows for operational deviation (periodic angle tolerance) of two tenths of a degree from the commissioned angle. It is imperative that the reported commissioned angle be the angle for which obstacle clearance and operational criteria has been applied. In other words, the desired angle, the computed angle, and the commissioned angle are actually the same.

The allowable periodic deviation of $.2^{o}$ is applied to this angle and not the angle found during commissioning inspections. Because the periodic tolerance of $.2^{o}$ is applied to the commissioned angle, operations/maintenance personnel must determine the acceptability of a facility which will require the application of an imbalanced periodic tolerance. An example of this situation is as follows: Desired/commissioned angle = 3.00^{o}, angle found during commissioning = 2.90^{o}, allowable deviation = $3.00 \pm .2^{o}$ or 2.8 to 3.2^{o}.

216.3207 PAR Serving ILS Runway. When checking the PAR at locations where an ILS is installed to serve the same runway, both azimuths and glide slopes should be as nearly coincident as possible from ILS approach zone Point "B" outward towards the glidepath intercept point. Coincidence probably won't be maintained from Point "B" to touchdown due to the characteristics of the ILS glide slope inside Point "B." Coincidence of the azimuths and glidepaths of the PAR and ILS is essential to preclude pilot confusion from different indications of the ILS and PAR. Coincidence may be checked using the AFIS, theodolite, precision range mark procedure, or a microamp comparison with the ILS. If any doubt exists as to glide angle coincidence, the theodolite or AFIS shall be used. Perform a PAR approach as directed by the final controller and monitor the approach using the ILS. Areas of non-coincidence of the azimuths and glide-paths should be noted. During commissioning, adjustments to achieve coincidence may be made if desired. In addition to requirements in Section 216.3206, those PAR's which have controller-selected glide angles shall be checked for coincidence with the published ILS glidepath.

216.3208 Lower Safe Limit Alignment. The lower safe limit shall be checked as follows:

a. Fly in-bound 5 to 7 miles from the runway on the lower safe limit line and maintain "on-path" at the controller's direction. Maintain "on path" position to the runway, or until it becomes obvious that a pull-up is necessary to avoid obstacles. By flying the lower safe limit line, the aircraft should clear all obstacles prior to passing the runway threshold.

b. Scopes which do not have the lower safe limit line portrayed shall be checked in the same manner as above. The controller will supply information to the flight inspector so that he can fly the lower safe limit altitudes (below which a missed approach would be necessary), and be clear of obstacles prior to passing the runway threshold.

The lower safe limit angle is normally 0.5^{o} less than the glidepath angle. During the commissioning flight checks, the lower safe limit angle shall be established in the same manner as the glide slope angle (see paragraph 216.3206). Verification of the angle on subsequent checks is not necessary unless requested by maintenance; all that is required is that satisfactory obstacle clearance is provided while flying the lower safe limit line/altitude as described above.

216.3209 Approach Lights. The approach lights shall be inspected in accordance with Section 218 of this manual.

216.3210 Communications. During commissioning inspections, check communications on all required frequencies, including standby equipment for clarity and coverage, from the final controller position. Normally, this inspection is combined with other checks.

216.3211 Standby Equipment. If dual channel is installed, the standby channel will be spot checked to assure that it is functioning in a manner equal to the primary equipment.

216.3212 Standby Power. Standby power shall be inspected in accordance with Section 106.43 of this manual.

216.4 ANALYSIS. A flight inspection of a ground radar facility always uses the services of the ground controllers, maintenance, and/or engineering personnel because of the inherent and unique characteristics of the entire system.

The flight inspector is responsible for determining that the PAR conforms to the specified tolerances. Any discrepancies found which could be attributable to controller technique should be brought to the attention of the ground supervisory personnel.

216.5 TOLERANCES. All precision approach radars shall meet the tolerances set forth below for an unrestricted classification. Classification of the facility based on flight inspection results is the responsibility of the flight inspector.

a. Azimuth Course Alignment. The azimuth course line will coincide as nearly as practicable with runway centerline extended. The maximum course alignment error at the runway threshold shall not exceed 30 feet or 0.2^{o}, whichever is greater. Reference point for measuring 0.2^{o} is on runway centerline at the approach end of the runway.

b Course Deviation Accuracy. Target presentation and aircraft positioning shall be coincident throughout the maneuvering area.

c. Range Accuracy. Range accuracy shall indicate the position of the aircraft to within 2 percent of the true range.

d. Usable Distance. The radar shall be capable of detecting an aircraft to a minimum of 7.5 miles from touchdown within the azimuth and elevation sector portrayed on the radar scope.

e. Moving Target Indicator (MTI). Operation of the MTI shall not cause loss of a workable signal at other than blind speed.

f. Glide Path Alignment (Angle).

(1) Commissioning. During commissioning inspections, the actual glidepath angle shall be optimized within 0.1^{o} of the desired angle.

(2) Periodic, Special. The glidepath alignment shall be within 0.2 degrees of the published angle.

NOTE: The terms programmed, desired, commissioned, and published are synonymous and define the angle to which obstacle clearance criteria and periodic angle tolerances are applied.

g. PAR/ILS Comparison. Glidepath alignment of PAR and ILS serving the same runway shall be within 0.2^{o}. The 0.2^{o} tolerance applies to the "as found" angle of the PAR versus the published glide slope angle. PAR/ILS glidepath angle comparison is measured from Point "B" of the ILS approach Zone 2 outward to avoid ILS glidepath characteristics inside of Point "b."

h. Lower Safe Limit Alignment (Angle). An approach on the lower safe limit line shall provide clearance from all obstacles from glidepath intercept to runway threshold as follows:

(1) When the aircraft is flown on the lower safe limit line.

(2) When the aircraft is flown at a minimum angle established by the controller at facilities not having lower safe limit lines portrayed on the scopes.

i. Approach Lighting Systems. See Section 218.

j. Communications. See Section 211.

k. Standby Equipment. See paragraph 106.42.

l. Standby Power. See paragraph 106.43.

216.6 ADJUSTMENTS. See paragraph 106.45

216.7 Records, Reports, and Notices To Airmen. See Sections 107 and 108.

SECTION 217. INSTRUMENT LANDING SYSTEM (ILS)

CROSS INDEX

CROSS INDEX -- ***Continued***

SECTION 217. INSTRUMENT LANDING SYSTEM (ILS)

217.1 INTRODUCTION. This section provides instructions and performance criteria for certifying localizer and glidepath which operate in the VHF and UHF band. Flight inspection of the associated facilities used as integral parts of the instrument landing system shall be accomplished in accordance with instructions and criteria contained in their respective sections of this manual or in other appropriate documents.

a. The two basic types of localizers are single frequency and dual frequency. Localizers are normally sited along the centerline of the runway; however, some are offset from the centerline. Localizer type directional aids (LDA) may be located at various positions about the runway.

b. Another type of facility which provides azimuth guidance is the simplified directional facility (SDF). The two basic types of SDF facilities are the null reference type and the phase reference type.

c. The three basic image array glide slope systems are null reference, sideband reference, and capture effect. The two non-image array systems are the endfire and the waveguide.

d. Flight inspection techniques using the FAA automated flight inspection system (AFIS) are detailed in other directives. Where AFIS is available, these techniques shall be used to accomplish the approved procedures in this section.

217.11 ILS Zones and Points. ILS zones and points are defined in Section 301 and are illustrated in Figure 217-1.

217.2 PREFLIGHT REQUIREMENTS

217.21 Facilities Maintenance Personnel. Prepare for flight inspection in accordance with paragraph 106.31.

217.22 Flight Personnel. Prepare for flight inspection in accordance with paragraph 106.32.

217.23 Special Equipment Requirements. RTT or AFIS is required as follows:

a. Glide Slope

(1) Category (CAT) I—On site, commissioning, after accident, and categorization inspections, and for confirmation of out-of-tolerance conditions.

(2) CAT II and III—For all inspections to determine structure and angle.

b. Localizer. To confirm marginal or out-of-tolerance conditions.

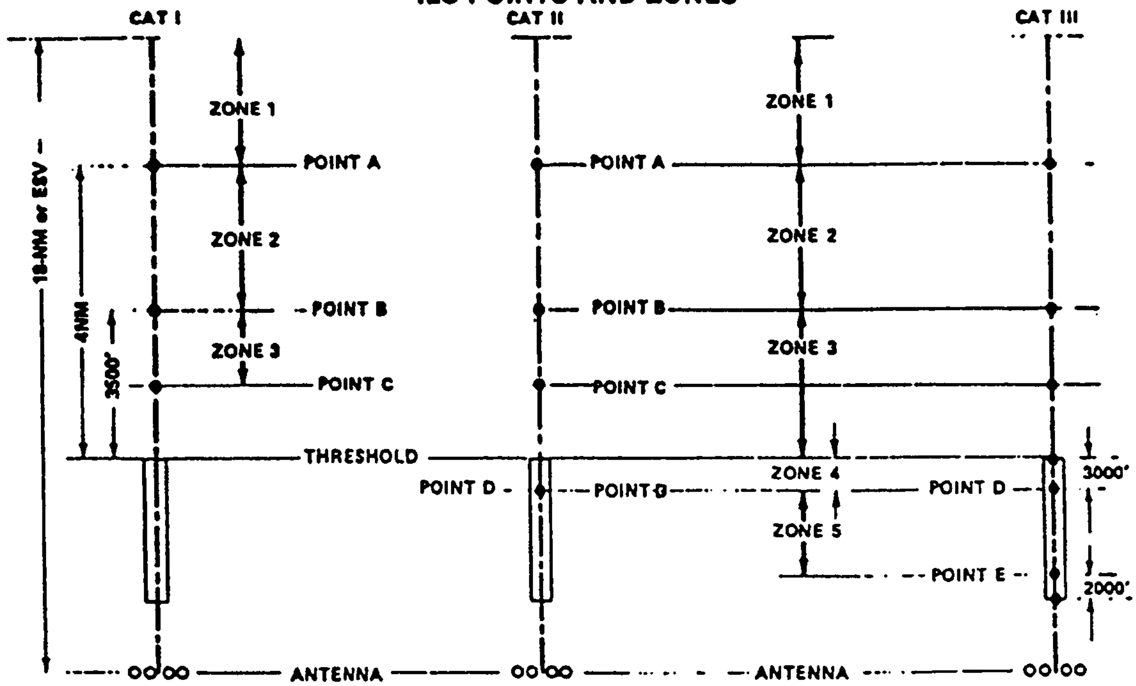
c. RTT or AFIS shall be used at any time that more definitive alignment and structure analysis are required (e.g., engineering requirements, research and development, etc.). RTT is used to obtain actual facility performance when AFIS is not available.

217.231 When RTT or AFIS equipment is not available, a standard theodolite may be used except during glide slope category determination inspection or for the measurement of actual glidepath angles during commissioning checks.

217.24 Glidepath Origination Point. The glidepath origination point is required for AFIS-equipped aircraft. For image array glide slopes, engineering personnel shall supply the latitude/longitude of the antenna mast and the mean sea level elevation of the glidepath origination point. For non-image arrays, engineering personnel shall supply the latitude, longitude, and mean sea level altitude of the glidepath origination point.

Figure 217-1A

ILS POINTS AND ZONES



TYPICAL OFFSET ILS

TYPICAL OFFSET LOCALIZER

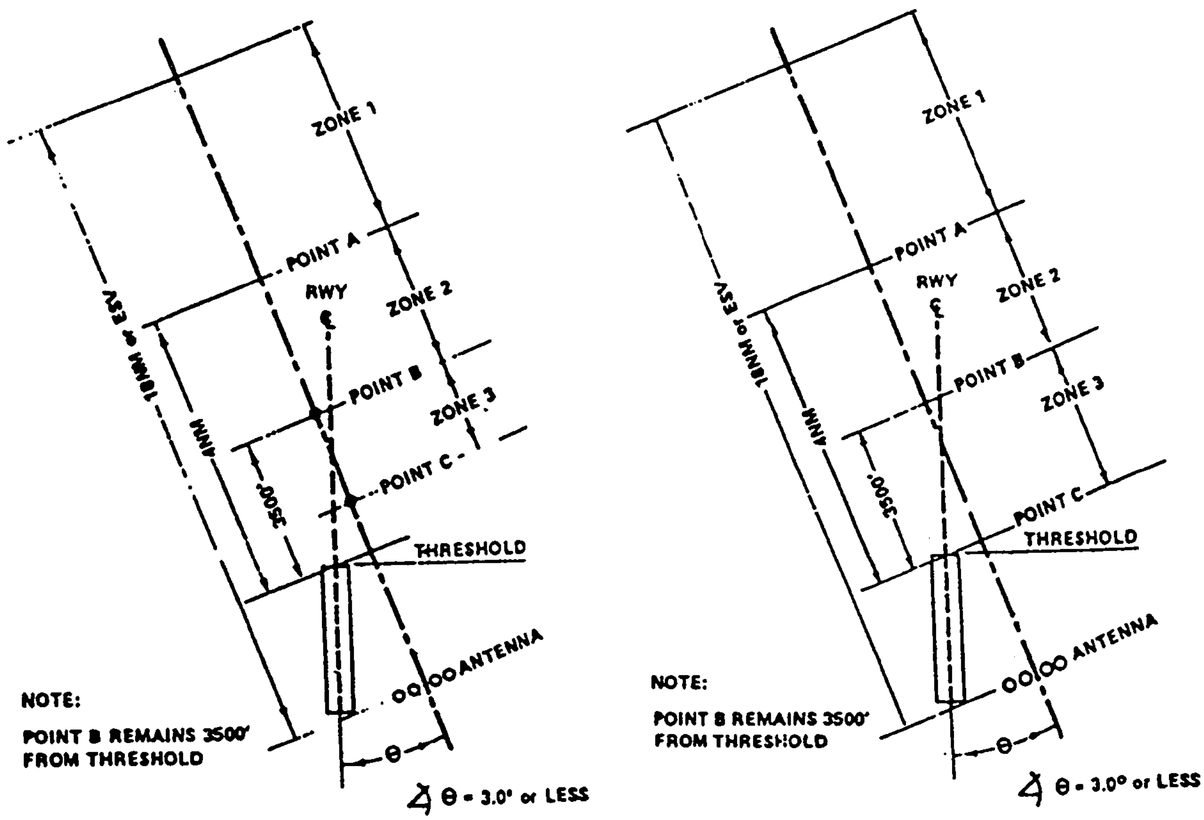
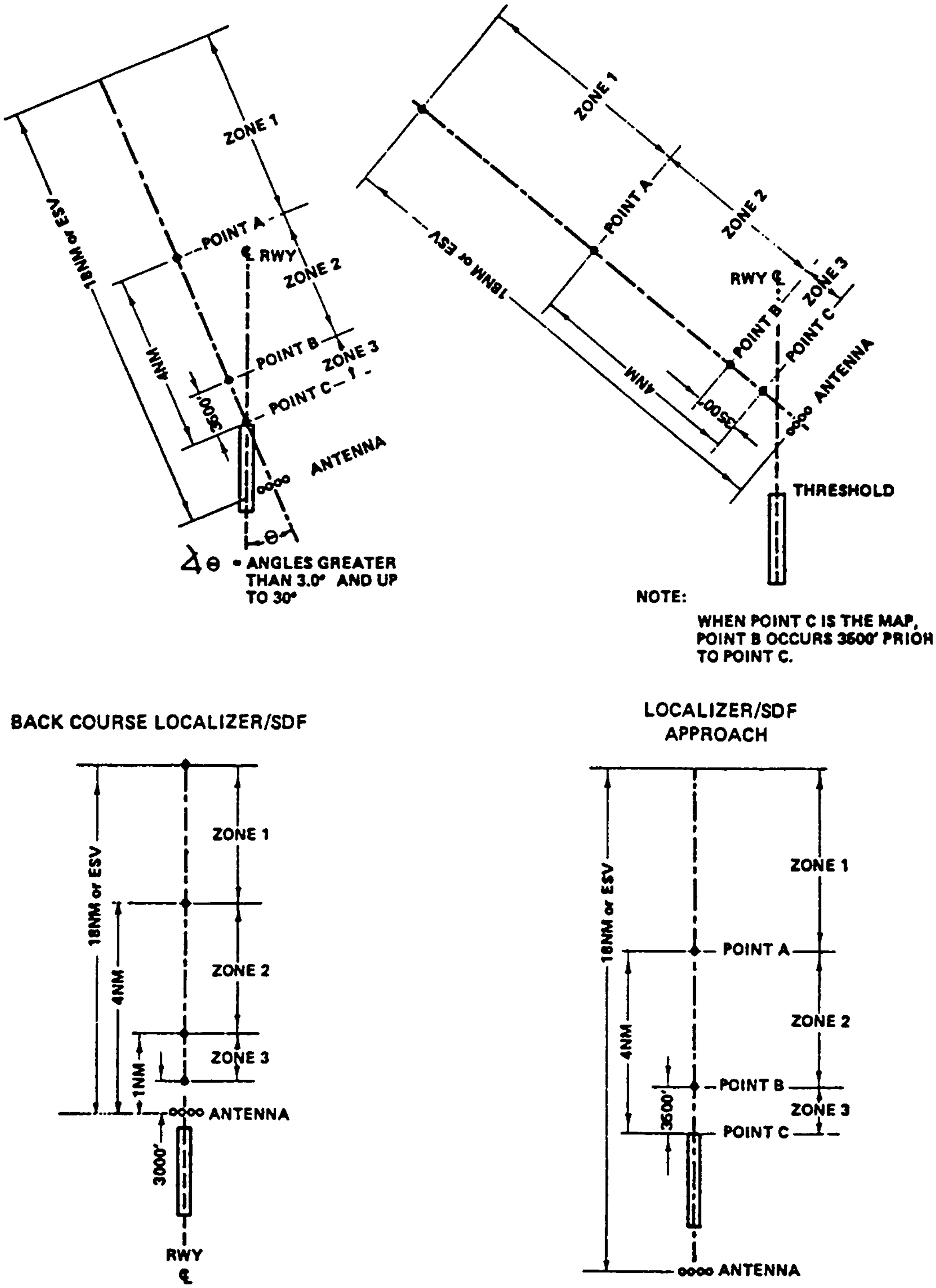


Figure 217-1B

ZONES AND POINTS OF LDA's AND SDF's



217.25 Theodolite Procedures. The RTT or theodolite will be positioned in accordance with the following criteria:

a. Glide Slope Image Array Systems

(1) First Method

(a) Through engineering survey data or by use of the theodolite itself, determine the difference in elevation, to the nearest inch, between the ground plane at the base of the antenna mast and the center of the runway opposite the mast. This can be accomplished by sighting with the theodolite to a surveyor's marker pole placed at the center of the runway opposite the mast or vice versa. If the crown of the runway is higher than the ground level at the antenna, the difference is treated as a minus value; if lower, the difference is a plus value. If the elevation difference determined above (minus value only) provides a comfortable eyepiece height, the theodolite may be positioned at that height at the base of the antenna mast and steps (b) through (e) disregarded.

NOTE: Where the elevation of the base of the antenna mast is more than 62 inches lower than the center of the runway opposite the antenna, alternate procedures to theodolite positioning should be considered. One such alternate is to apply steps (a) through (e) using an image position for the antenna base on the side of the runway opposite the facility.

(b) Place the theodolite at the base of the glide slope antenna mast with the eyepiece 62 inches above the ground.

(c) Sight along a line between the antenna mast and the center of the runway threshold with the eyepiece set at the commissioned or desired vertical angle.

(d) Using a marker pole, determine the position on the ground along the line in step (c) which is exactly 124 inches, plus or minus the elevation difference obtained from step (a). For example, if the runway is higher, subtract the elevation difference from 124 inches, if lower, add the elevation difference to 124 inches.

(e) Establish the eyepiece height of the theodolite at 62 inches with the commissioned angle (or desired vertical angle) of the glidepath set in the theodolite.

(2) Second Method. This method applies to locations where the transverse slope between the glide slope antenna base and the runway edge is irregular, e.g., pedestal runway. The determination of the irregular transverse slope and use of this procedure shall be made by engineering/ installation personnel.

(a) Place the theodolite at the base of the glide slope antenna mast with the eyepiece 62 inches above the ground.

(b) Sight along a line between the glide slope antenna mast and the center of the runway threshold with the eyepiece set at the commissioned angle (or desired vertical angle).

(c) Using a marker pole, determine the position on the ground where the optical angle passes through the 124-inch point of the marker pole. Mark this position for future use.

(d) This is the correct position for placing the theodolite with the eyepiece 62 inches above the ground. To verify that the theodolite barrel is aligned to the optical line of the glidepath, adjust the vertical reference to a negative glidepath angle, rotate the azimuth 180° and sight on the point established in step (2)(a). If this point is not aligned to the horizontal crosshair, an error in establishing the theodolite position has occurred and the procedure should be accomplished.

b. Waveguide Glide Slope

(1) Due to the complexity of determining the proper location of the theodolite, engineering personnel shall compute this location.

(2) The glidepath signal is considered to emanate from the mid-point of the array; therefore, the theodolite will be oriented to this plane.

(3) Correction Factors. Due to offset distance of the theodolite from the runway centerline and distance from the antenna array, parallax errors will be induced (dissimilar width sensitivities particularly in zone 3). Engineering personnel shall provide the flight inspection crew with correction factors to be applied to the RTT differential trace.

c. Endfire Glide Slope

(1) The glidepath signal is considered to emanate from the phase center of the array and at the elevation plane determined by engineering personnel.

(2) The theodolite shall be positioned using the data in paragraph c(1) corrected for eyepiece height.

d. Localizer. The use of a theodolite, AFIS, or RTT is not required for any inspection on a localizer sited along runway centerline, regardless of category, providing performance can be satisfactorily evaluated by flying a visual centerline track.

The position of the theodolite, when used during localizer evaluations, will be placed on a line perpendicular to the localizer antenna array aligned so as to sight along the reciprocal of the calculated true course and at a point as close to the center of the array as possible.

e. Aircraft Tracking

(1) Glide Slope. The optimum tracking point on the flight inspection aircraft is the glide slope antenna.

(2) Localizer. The optimum tracking point on the flight inspection aircraft is the localizer antenna.

217.3 FLIGHT INSPECTION PROCEDURES

217.31 Checklist

a. ILS Site Evaluations. Site evaluations if performed, are made prior to installation of permanent equipment. The need for a site evaluation, and additional requirements, shall be determined by engineering personnel on the basis of individual site conditions.

b. Periodic Checks. A periodic check without monitors shall consist of an inspection of the localizer and glide slope transmitter that is on the air, plus the operating transmitter of the supporting NAVAIDs. If out-of-tolerance conditions are found, inspect the standby equipment, if available.

c. Periodic with Monitors. Consists of a periodic with monitors performed on both primary and standby equipment, plus the operating transmitter of the supporting NAVAIDs. Facilities that have dual parallel monitors require a monitor evaluation on one transmitter only. Facilities that have two individual monitors require evaluations on each transmitter.

d. Frequency Change. Following a localizer (SDF, LDA) or ILS frequency change, conduct a special inspection that fulfills the following requirements: Periodic with monitors (Pm), RF power alarm monitor, and spectrum analysis.

e. Other Component Changes. See paragraph 104.5.

217.3101 Facility Checklists by Type. Flight inspection requirements are contained in the following checklists and in the discussion paragraphs in this section. The checklists are provided as a guide and do not necessarily indicate a sequence of checks. Consult the text to ensure a complete inspection.

Legend:

Fc = Localizer front course.

Bc = Localizer back course.

A = After accident inspection.

C = Commissioning or commissioning type equipment.

E = Site evaluation.

Pm = Periodic inspection with monitors.

P = Periodic inspection without monitors.

a. **Single Frequency Localizer,** LDAs, SDFs, and Dual Frequency MRN-7.

NOTE: Bc checks do not apply to uni-directional antennas and MRN-7.

REMARKS:

(1) Maintenance request.

(2) Adjustments to carrier modulation balance will require a subsequent check of course alignment.

(3) Width and clearance should be measured prior to the phasing check. If, after the quadrature phase check, the width has remained the same or has narrowed and/or the clearances have increased from the first width and clearance check, then the phasing has been improved. Final determination of optimum phase should be discussed with facilities maintenance personnel.

(4) Applicable to phase reference SDFs only.

(5) Facilities with dual transmitters and single solid state modulators—check both transmitters.

Type Check	Ref. Para. 217.xxxx	Inspection				Facility Configuration	Measurements Required					
		E	C	Pm	P		MOD	WIDTH	SYM	CLR	ALIGN	STRUC
Spectrum Analysis	.3201	Reserved										
Ident. & Voice	.3214	(1)	x	x	x							Fc&Bc
Modulation Level	.3202	x	x	x	x	Normal	Fc					
Modulation Equality	.3202 .3203	(1)	(1)			Carrier Only						
Phasing (3)	.3205	(1)	(1)			Quadrature	Set to Value of Modulation Equality					
Width & Clearance	.3206 .3210	x	x	x	x	Normal		Fc&Bc	Fc&Bc	Fc&Bc		
Alignment and Structure	.3207	x	x	x	x	Normal	Fc				Fc&Bc	Fc&Bc
Polarization (One XMTR Only)	.3213	x	x	x	x	Normal						Fc&Bc
Monitors (5) Width	.3208	(1)	x	x		Wide Alarm		Fc&Bc		Fc&Bc		
		(1)	x			Narrow Alarm		Fc		Fc(4)		
Alignment		(1)	x			Alignment Alarms					Fc	
RF Power Monitor Reference	.3209	(1)	x			Reduced RF Power				Fc&Bc		Fc&Bc
High Angle Clearance (One XMTR Only)	.32101	x	x			Normal				Fc&Bc		
Standby Equipment	.3401 106.42		x	x								
Standby Power	.3402 106.43		x			Normal	Fc&Bc	Fc&Bc	Fc&Bc		Fc&Bc	

b. Dual Frequency Localizer (Excluding MRN-7).

REMARKS:

(1) Maintenance request.

(2) Adjustments to carrier modulation balance will require a subsequent check of course alignment.

(3) Width and clearance should be measured prior to the phasing check. If, after the quadrature phase check, the width has remained the same or has narrowed and/or the clearances have increased from the first width and clearance check, then the phasing has been improved. Final determination of optimum phase should be discussed with facilities maintenance personnel.

(4) Make this check on the back course of an independently monitored facility that has a back course procedure.

Type Check	Ref. Para.	Inspection				Transmitter Configuration		Measurements Required					
	217.xxxx	E	C	Pm	P	Course XMTR	Clearance XMTR	MOD	WIDTH	SYM	CLR	ALIGN	STRUC
Spectrum Analysis	.3201	Reserved											
Ident. & Voice	.3214	(1)	x	x	x								Fc&Bc
Power Ratio	.3204	x	x			RF Alarm	Normal						
Modulation Level	.3202	x	x			Normal	OFF	Fc					
		x	x			OFF	Normal	Fc					
		x	x	x	x	Normal	Normal	Fc					
Modulation Equality (2)	.3202 .3203	(1)	(1)			Carrier Only	OFF	Fc	Balance Determined by Maintenance				
		(1)	(1)			OFF	Carrier Only	Fc	Balance Determined by Maintenance				
Phasing (3)	.3205	(1)	(1)			Quad	OFF		Set to Value of Modulation Equality				
		(1)	(1)			OFF	Quad		Set to Value of Modulation Equality				
Width & Clearance	.3206 .3210	(1)	(1)			OFF	Normal		Fc				
		x	x	x	x	Normal	Normal		Fc(4)	Fc(4)	Fc(4)		
Alignment and Structure	.3207	x	x	x	x	Normal	Normal	Fc(4)				Fc(4)	Fc(4)
Polarization One XMTR Only)	.3213	x	x	x	x	Normal	Normal						Fc(4)

b. Dual Frequency Localizer (Excluding MRN-7).

REMARKS:

(1) Maintenance request.

(2) Adjustments to carrier modulation balance will require a subsequent check of course alignment.

(3) Width and clearance should be measured prior to the phasing check. If, after the quadrature phase check, the width has remained the same or has narrowed and/or the clearances have increased from the first width and clearance check, then the phasing has been improved. Final determination of optimum phase should be discussed with facilities maintenance personnel.

(4) Make this check on the back course of an independently monitored facility that has a back course procedure.

Type Check	Ref. Para. 217.xxxx	Inspection				Transmitter Configuration		Measurements Required					
		E	C	Pm	P	Course XMTR	Clearance XMTR	MOD	WIDTH	SYM	CLR	ALIGN	STRUC
Spectrum Analysis	.3201	Reserved											
Ident. & Voice	.3214	(1)	x	x	x								Fc&Bc
Power Ratio	.3204	x	x			RF Alarm	Normal						
Modulation Level	.3202	x	x			Normal	OFF	Fc					
		x	x			OFF	Normal	Fc					
		x	x	x	x	Normal	Normal	Fc					
Modulation Equality (2)	.3202 .3203	(1)	(1)			Carrier Only	OFF	Fc	Balance Determined by Maintenance				
		(1)	(1)			OFF	Carrier Only	Fc	Balance Determined by Maintenance				
Phasing (3)	.3205	(1)	(1)			Quad	OFF		Set to Value of Modulation Equality				
		(1)	(1)			OFF	Quad		Set to Value of Modulation Equality				
Width & Clearance	.3206 .3210	(1)	(1)			OFF	Normal		Fc				
		x	x	x	x	Normal	Normal		Fc(4)	Fc(4)	Fc(4)		
Alignment and Structure	.3207	x	x	x	x	Normal	Normal	Fc(4)				Fc(4)	Fc(4)
Polarization One XMTR Only)	.3213	x	x	x	x	Normal	Normal						Fc(4)

c. Null Reference Glide Slope.

CODE: W/A/S = Width, Angle, Symmetry

REMARKS:

(1) Maintenance request.

(2) If structure below path tolerances cannot be met, clearance procedures and tolerances will be applied.

(3) Required on commissioning type inspections.

Type Check	Ref. Para. 217.xxxx	Inspection E	Inspection C	Inspection Pm	Inspection P	Facility Configuration	Measurements Required MOD	WIDTH	ANGLE	SYM	STRUC BELOW PATH	CLEARANCE	STRUC
Spectrum Analysis	.3301	Reserved											
Engineering Support Tests	.3305	(1)	(1)			As Required							
Modulation Level	.3302	X	X	X	X	Normal	X						
Modulation Equality	.3303	(1)	(1)			Carrier Only	X						
Phasing	.3304	(1)	(1)			Quadrature	SET TO VALUE FOUND IN MODULATION EQUALITY						
Spurious Radiation	.33053	(1)	(1)			Dummy Load Radiating Signal							X
W/A/S	.3306 .3313	X	X	X	X	Normal		X	X	X	X(2)		
Structure	.3310 .3313	X	X	X	X	Normal	X						X
Clearance	.3307	X	X			Normal						X	
Tilt (One XMTR Only)	.3309	X	X			Normal	X		X			X	
Mean Width	.3308	(1)	X			Normal		X		X			
Monitors Width	.3313	(1)	X	X		ADV Phase		X	X		X(2)	(3)	
		(1)	X	X		RET Phase		X	X		X(2)	(3)	
		(1)	X	X		Wide Alarm		X	X		X(2)	(3)	
			X			Narrow Alarm		X	X		X(2)		
RF Power Monitor Reference	.3314	(1)	X			Reduced RF Power							
Standby Equipment	.3401 106.42		X	X									
Standby Power	.3402 106.43		X			Normal	X	X	X	X	X(2)		

d. Sideband Reference Glide Slope.

CODE: W/A/S = Width, Angle, Symmetry

REMARKS:

(1) Maintenance request.

(2) If structure below path tolerances cannot be met, clearance procedures and tolerances will be applied.

(3) Required on commissioning type inspections.

(4) Check on one transmitter only if the equipment has a common power divider and parallel monitors.

Type Check	Ref. Para. 217.xxxx	Inspection				Facility Configuration	Measurements Required						
		E	C	Pm	P		MOD	WIDTH	ANGLE	SYM	STRUC BELOW PATH	CLEAR-ANCE	STRUC
Spectrum Analysis	.3301	Reserved											
Engineering Support Tests	.3305	(1)	(1)			As Required							
Modulation Level	.3302	X	X	X	X	Normal	X						
Modulation Equality	.3303	(1)	(1)			Carrier Only	X						
Phasing	.3304	(1)	(1)			As Required	SET TO VALUE FOUND IN MODULATION EQUALITY						
Spurious Radiation	.33053	(1)	(1)			Dummy Load Radiating Signal							X
W/A/S	.3306 .3313	X	X	X	X	Normal		X	X	X	X(2)		
Structure	.3310 .3313	X	X	X	X	Normal	X						X
Clearance	.3307	X	X			Normal						X	
Tilt (One XMTR Only)	.3309	X	X			Normal	X		X			X	
Mean Width	.3308	(1)	X			Normal		X		X			

d. Sideband Reference Glide Slope. Continued

Type Check	Ref. Para. 217.xxxx	Inspection				Facility Configuration	Measurements Required						
		E	C	Pm	P		MOD	WIDTH	ANGLE	SYM	STRUC BELOW PATH	CLEAR-ANCE	STRUC
Monitors Angle	.3313		X			High Angle (4)		X	X(4)		X(2)		
		(1)	X	X		Low Angle (4)		X	X(4)		X(2)	(3)	
Width						Upper Antenna:							
			X	X		ADV Phase		X	X		X(2)	(3)	
			X	X		RET Phase		X	X		X(2)	(3)	
						Main Sideband:							
			X			ADV Phase		X	X		X(2)		
			X			RET Phase		X	X		X(2)		
		(1)	X	X		Wide Alarm		X	X		X(2)	(3)	
			X			Narrow Alarm		X	X		X(2)		
RF Power Monitor Reference	.3314	(1)	X			Reduced RF Power							
Standby Equipment	.3401 106.42		X	X									
Standby Power	.3402 106.43		X			Normal	X	X	X	X	X(2)		

e. Capture Effect Glide Slope.

CODE: W/A/S = Width, Angle, Symmetry

REMARKS:

(1) Maintenance request.

(2) If structure below path tolerances cannot be met, clearance procedures and tolerances will be applied.

(3) Required on commissioning type inspections.

(4) Perform this check on both transmitters at the request of maintenance.

(5) Commissioning on the transmitter used to check phase verification is not required if the phaser monitor/limit setting is 15 degrees or less.

Type Check	Ref. Para. 217.xxxx	Inspection				Facility Configuration	Measurements Required						
		E	C	Pm	P		MOD	WIDTH	ANGLE	SYM	STRUC BELOW PATH	CLEAR-ANCE	STRUC
Spectrum Analysis	.3301	Reserved											
Engineering Support Tests	.3305	(1)	(1)			As Required							
Modulation Level	.3302	X	X	X	X	Normal:	X						
Modulation Equality	.3303	(1)	(1)			Carrier Only	X						
Phasing Proc. 1 or 2	.3304	(1)	(1)			As Required	SET TO VALUE FOUND IN MODULATION EQUALITY						
Phase Verification (4)	.3304	(1)	(1)			As Required	X	X	X	X		X	
Spurious Radiation	.33053	(1)	(1)			Dummy Load Radiating Signal							X
W/A/S	.3306 .3313	X	X	X	X	Normal		X	X	X	X(2)		
Structure	.3310 .3313	X	X	X	X	Norma1	X						X
Clearance	.3307	X	X			Normal						X	
Tilt (One XMTR Only)	.3309	X	X			Normal	X		X			X	
Mean Width	.3308	(1)	X			Normal		X		X			

e. Capture Effect Glide Slope—Continued.

Type Check	Ref. Para. 217.xxxx	Inspection E	Inspection C	Inspection Pm	Inspection P	Facility Configuration	Measurements Required MOD	WIDTH	ANGLE	SYM	STRUC BELOW PATH	CLEAR-ANCE	STRUC
Monitors Width	.3313	(1)	X	X		Middle Antenna ADV Phase		X	X		X(2)	(3) (5)	
		(1)	X	X		RET Phase		X	X		X(2)	(3) (5)	
		(1)	X			Narrow Alarm		X	X		X(2)		
		(1)	X	X		Primary XMTR Wide Alarm and Decrease the Modulation of the Clearance XMTR to Modulation Alarm		X	X		X(2)	(3)	
		(1)	X			Middle Antenna Attenuate		X	X		X(2)	(3)	
		(1)	X	X		Upper Antenna Attenuate		X	X		X(2)	(3)	
RF Power Monitor Reference	.3314	(1)	X			Reduced RF Power							
Standby Equipment	.3401 106.42		X	X									
Standby Power	.3402 106.43		X			Normal	X	X	X	X	X(2)		

f. Waveguide Glide Slope with Auxiliary Waveguide Antennas.

NOTE: For those waveguide glide slopes that do not have auxiliary waveguide antennas, complete all checklist items except the following monitor checks: Upper Auxiliary Waveguide—attenuate, advance and retard—dephase; Lower Auxiliary Waveguide—attenuate; Upper and Lower Waveguide—simultaneously advance and retard dephase.

CODE: W/A/S = Width, Angle, Symmetry

REMARKS:

(1) Maintenance request.

(2) If structure below path tolerances cannot be met, clearance procedures and tolerances will be applied.

(3) Required on commissioning type inspections.

(4) This check can be made on either the upper or lower main antenna feed but both steps must be performed on the same feed.

Type Check	Ref. Para. 217.xxxx	Inspection				Facility Configuration	Measurements Required						
		E	C	Pm	P		MOD	WIDTH	ANGLE	SYM	STRUC BELOW PATH	CLEAR-ANCE	STRUC
Spectrum Analysis	.3301	Reserved											
Engineering Support Tests	.3305	(1)	(1)			As Required							
Modulation Level	.3302	X	X	X	X	Normal	X						
Modulation Equality	.3303	(1)	(1)			Carrier Only							
Spurious Radiation	.33053	(1)	(1)			Dummy Load Radiating Signal							X
W/A/S	.3306	X	X	X	X	Normal		X	X	X	X(2)		
Structure	.3310	X	X	X	X	Normal	X						X
Clearance	.3307	X	X			Normal						X	
Tilt (One XMTR Only)	.3309	X	X			Normal	X		X			X	
Mean Width	.3308	(1)	X			Normal		X		X			

f. Waveguide Glide Slope with Auxiliary Waveguide Antennas.—Continued

Type Check	Ref. Para. 217.xxxx	Inspection E	C	Pm	P	Facility Configuration	MOD	WIDTH	ANGLE	SYM	STRUC BELOW PATH	CLEAR-ANCE	STRUC
Monitors Width	.3313	(1)	X	X		Wide Alarm		X	X		X(2)	(3)	
			X			Narrow Alarm		X	X		X(2)		
						Main Sideband:							
			X	X		ADV Phase		X	X		X(2)	(3)	
			X	X		RET Phase		X	X		X(2)	(3)	
One XMTR Only						Upper Auxiliary Waveguide:							
			X			Attenuate		X	X(4)			X	X
			X			ADV Phase		X	X(4)			X	X
			X			RET Phase		X	X(4)			X	X
One XMTR Only						Lower Auxiliary Waveguide:							
			X			Attenuate		X	X(4)			X	X
One XMTR Only						Upper & Lower Waveguide Simultaneously:							
			X			ADV Phase		X	X		X(2)		X
			X			RET Phase		X	X		X(2)		X
One XMTR Only						Main Waveguide Feed Phaser:							
			X	X		ADV Phase (4)		X	X		X(2)	(3)	
			X	X		RET Phase (4)		X	X		X(2)	(3)	
Angle One XMTR Only			X			Lower Main Waveguide Feed: Attenuate (High Angle)		X	X		X(2)		
One XMTR Only			X			Upper Main Waveguide Feed: Attenuate (Low Angle)		X	X		X(2)	(3)	
RF Power Monitor Reference	.3314	(1)	X			Reduced RF Power							
Standby Equipment	.3401 106.42		X	X									
Standby Power	.3402 106.43		X			Normal	X	X	X	X	X(2)		

f. Waveguide Glide Slope with Auxiliary Waveguide Antennas.—Continued

Type Check	Ref. Para. 217.xxxx	Inspection E	C	Pm	P	Facility Configuration	Measurements Required MOD	WIDTH	ANGLE	SYM	STRUC BELOW PATH	CLEAR-ANCE	STRUC
Monitors Width	.3313	(1)	X	X		Wide Alarm		X	X		X(2)	(3)	
			X			Narrow Alarm		X	X		X(2)		
						Main Sideband:							
			X	X		ADV Phase		X	X		X(2)	(3)	
			X	X		RET Phase		X	X		X(2)	(3)	
One XMTR Only						Upper Auxiliary Waveguide:							
			X			Attenuate		X	X(4)			X	X
			X			ADV Phase		X	X(4)			X	X
			X			RET Phase		X	X(4)			X	X
One XMTR Only						Lower Auxiliary Waveguide:							
			X			Attenuate		X	X(4)			X	X
One XMTR Only						Upper & Lower Waveguide Simultaneously:							
			X			ADV Phase		X	X		X(2)		X
			X			RET Phase		X	X		X(2)		X
One XMTR Only						Main Waveguide Feed Phaser:							
			X	X		ADV Phase (4)		X	X		X(2)	(3)	
			X	X		RET Phase (4)		X	X		X(2)	(3)	
Angle One XMTR Only			X			Lower Main Waveguide Feed: Attenuate (High Angle)		X	X		X(2)		
One XMTR Only			X			Upper Main Waveguide Feed: Attenuate (Low Angle)		X	X		X(2)	(3)	
RF Power Monitor Reference	.3314	(1)	X			Reduced RF Power							
Standby Equipment	.3401 106.42		X	X									
Standby Power	.3402 106.43		X			Normal	X	X	X	X	X(2)		

g. **Endfire Glide Slope—Standard (capture effect in the horizontal plane)—Continued.**

Type Check	Ref. Para. 217.xxxx	Inspection				Facility Configuration		Measurements Required						
		E	C	Pm	P	Primary XMTR	Clear XMTR	MOD	WIDTH	ANGLE	SYM	STRUC BELOW PATH	CLEAR-ANCE	STRUC
Monitors Width	.3313	(1)	X	X		Wide Alarm	Norm		X	X		X(2)	(3)	
Phase		(1)	X	X		ADV Phase (4)	Norm		X	X		X(2)	(3)	
		(1)	X	X		RTD Phase (4)	Norm		X	X		X(2)	(3)	
		(1)	X			Narrow Alarm	Norm		X	X		X(2)		
Angle		(1)	X	(1)		Main Array: Dephase for High Angle	Norm		X	X		X(2)		
		(1)	X	X		Main Array: Dephase for Low Angle	Norm		X	X		X(2)	(3)	
RF Power Monitor Reference	.3314	(1)	X			Reduced RF Power	Reduced RF Power							
Transverse Structure	.3311		(1)			Norm	ADV CLR ANT Phase							X
			(1)			Norm	RET CLR ANT Phase							X
Standby Equipment	.3401 106.42		X	X										
Standby Power	.3402 106.43		X					X	X	X	X	X(2)		

217.3102 General Checklist. During a specific inspection, check the following items:

	A	E	C	Pm	P
75 Mhz Marker Beacons	X	-	X	X	X
Compass Locator	X	-	X	X	X
DME	X	-	X	X	X
Lighting Systems	X	-	X	X	X
Terminal En Route Procedures (See Section 214)	X	(1)	X	(1)	(1)

(1) As required by ground technical or flight inspection personnel.

217.32 Detailed Procedures - Localizers. Unless otherwise noted, the following procedures apply to all localizers, offset localizers, LDAs, and SDFs.

217.3201 Spectrum Analysis. Reserved.

217.3202 Modulation Level. This check measures the modulation of the radiated signal.

a. Approved Procedure--Front Course. Measure modulation while inbound on the localizer, between 10 miles and 3 miles from the localizer antenna, and on glidepath (at LCA for localizer-only facilities). Preliminary checks may be made when transitioning the "on-course" position during course width and symmetry measurements; however, they must be validated while flying inbound on-course.

b. Approved Procedure--Back Course. Measure modulation by using the flight procedures described in a. above. On single frequency localizers, adjustments to front course modulation will also affect the back course; therefore, adjustments are not required on the back course. Where a separate antenna provides clearance, as well as a back course (such as the waveguide system), modulation checks and adjustments of the clearance transmitter(s) are valid only while on the back course, unless the course transmitter is OFF.

217.3203 Modulation Equality. This check is performed to obtain a crosspointer value which will be used as a reference for phasing.

Approved Procedure. Position the aircraft as outlined in paragraph 217.3202, Modulation Level. Adjustments to modulation equality will require a subsequent check of course alignment,

217.3204 Power Ratio Check. The purpose of this check is to measure the ratio of power between the course and clearance transmitters of dual frequency localizers.

a. Approved Procedure. Although this check is made with the course transmitter in RF Power alarm, a 10dB or greater differential is always required with the transmitters in normal.

(1) When using the spectrum analyzer, position the aircraft on the localizer on-course within 10 miles and in line-of-sight of the antenna or parked on the runway on-course in line-of-sight of the antenna. Compare the relative signal strength of the course and clearance transmitters with the course transmitter in RF power alarm and the clearance transmitter in normal.

(2) If a spectrum analyzer is not available, position the aircraft on the runway centerline/on-course at or near the approach end of the runway in line-of-site of the antenna. Use the AGC meter or equivalent and note the voltage level of the facility in the following configurations:

(a) Course transmitter in RF alarm; clearance transmitter OFF.

(b) Clearance transmitter in normal; course transmitter OFF.

Compute the power ratio using the dual frequency power ratio formula (see Section 302).

217.3205 Phasing. The purpose of this check is to determine that the phase relationship between the sideband and carrier energy is optimum. The facility will normally be phased using ground procedures. No specific requirement exists for airborne phasing.

a. Approved Procedure--Front Course. Since antennas vary greatly, obtain the correct azimuth for phasing the facility from facility maintenance personnel. Fly inbound toward the antenna on the appropriate azimuth at LCA between 10 and 3 miles. Transmit the crosspointer values to assist the ground technician to adjust the phasing. The optimum quadrature phase condition is established when the microampere deflection is the same as that found when checking modulation equality.

b. Approved Procedure--Back Course. If maintenance requests phasing on the back course, apply the procedures described in a. above.

217.3206 Course Sector Width and Symmetry. The purpose of this check is to establish and maintain a course sector width and ratio between half-course sectors that will provide the desired displacement sensitivity required at the procedural missed approach point (MAP) or threshold and be within the limitations of the procedural protected area.

a. Width Requirements. Localizers, offset localizers, and LDA's shall be tailored to a course sector width not greater than 6^{0} and a linear sector width of 700 feet at the following points:

(1) Point C for LDA and SDF

(2) Point B for runways less than 4000 feet long and for runways which do not conform to precision instrument design standards.

(3) Point T for facilities supporting CAT II and III operations and all other applications.

The tailoring requirement may be waived for facilities supporting other than CAT II or III operations if tailoring cannot be achieved due to siting constraints, performance derogation, etc.; however, the final width shall be established as close as possible to the optimum. The justification shall be included in the flight inspection report. If the course sector width on a facility which supports a precision approach will not provide for at least 400 feet linear width at the runway threshold, the course shall be restricted as unusable inside the point where the linear width is less than 400 feet. The commissioned course width of an SDF shall be no greater than 12.0°. If the course width is adjustable, it shall be tailored. USAF CAT I localizers with antenna to threshold distance which would cause the tailored width to be less than 3° will be commissioned at 3°. Facilities previously commissioned at less than 3° need not be widened only to meet the 3° requirement.

b. Approved Procedure. This procedure applies to the front course (and back course if it is used for an approach or missed approach). Measure the course sector width and symmetry between 4 and 14 miles from the localizer antenna at the LCA, providing the modulation levels are in tolerance. Higher altitudes up to ESV may be used, provided that a comparability check in the normal configuration was made (usually at commissioning) at the LCA and the higher altitude, and the results were within tolerance and were within $\pm 0.2°$ (if the higher altitude is used, it shall be documented on the data sheet). Subsequent inspections may be made at LCA, the higher altitude, or any altitude between.

(1) Basic Method. A crossing, perpendicular to the on-course, shall be made in each direction, maintaining a constant airspeed (to average out any wind component) over a checkpoint of a known distance from the localizer antenna, i.e., outer marker, FAF, etc. If ground speed or along-track outputs are available, only one crossing is required. Measure the course sector width and calculate the symmetry (use the appropriate formulas in Section 302).

(2) Theodolite or Tracking Device Method. Position the theodolite or tracking device in accordance with paragraph 217.25, Theodolite Procedures. Only one crossing is required; maintain a constant airspeed. Reference the course sector width to the azimuth reference marks of the theodolite (usually spaced 5° apart). Measure the course sector width, using a device such as 10 point dividers, and calculate the symmetry.

NOTE: An RTT may be used to track an aircraft throughout the course sector. Apply the course sector width received to the calibration of the RTT.

217.3207 Course Alignment and Structure. These checks measure the quality and alignment of the on-course signal. The alignment and structure checks are usually performed simultaneously; therefore, use the same procedures to check alignment and structure.

a. Approved Procedure. This procedure applies to the front course (and the back course) if it is used for an approach or missed approach).

(1) General. Evaluate the course along the designed procedural azimuth from the furthest point required by the type of inspection being conducted throughout the remaining zones. Maintain the published or proposed procedural altitudes through each approach segment until intercepting the glidepath and then descend on the glidepath to Point C or runway threshold.

(a) For a localizer-only approach, the published or proposed procedural altitudes shall be maintained in each segment, except the final segment shall be flown as follows: Upon reaching the FAF inbound, descend at a rate of approximately 400 feet per mile (930 feet per minute at 140 knots; 800 feet per minute at 120 knots) to an altitude of 100 feet below the lowest published MDA and maintain this altitude to Point C, which is the MAP. NOTE: See Section 301 definition of Point C for localizer only approaches.

b. For ILS approaches which support localizer-only minima, the procedure specified in (a) above shall be used in addition to the run on normal glidepath during the following inspections: Site, Commissioning, and Specials for antenna system change, user compliant or site modifications, and on a periodic inspection any time there is a significant deterioration of localizer structure.

c. For localizers which are aligned along the runway centerline, the aircraft may be positioned along the runway centerline by visual cues, or theodolite. When RTT or AFIS equipment is used, the localizer on-course signal shall be flown. For localizers which are not aligned along the runway centerline, theodolite, RTT, or AFIS are the preferred methods of evaluation. For localizers oriented toward a non-descript point in space, where adequate visual checkpoints are not available to validate actual course alignment, the alignment may be determined to be either Satisfactory (S), or Unsatisfactory (U) in lieu of course alignment values (refer to paragraph 214.32011). The initial monitor evaluation shall establish an equality of modulation reference for subsequent alignment and monitor comparison.

(2) Procedures for CAT II and III ILS.

(a) Site, Commissioning, Reconfiguration and Categorization Inspections. Use the procedures in paragraph a(1) until reaching point C. Cross point C at 100 feet, runway threshold at approximately 50 feet, and continue on the extended glidepath angle to the touchdown point. Continue the landing roll and determine the actual course alignment for ILS zones 4 and 5. Measure the course structure from the actual alignment. If the actual alignment for zones 4 and 5 cannot be determined using this method, taxi the aircraft along the runway centerline from the runway threshold to point E. Record the raw crosspointer information and mark the threshold, point D and point E. Manually calculate the actual course alignment and structure for each of the required zones.

(b) Periodic or Special Inspections which require Structure Analysis. Use the procedures in paragraph a(1) until reaching point C. Cross point C at 100 feet, runway threshold at 50 feet, and then conduct a low approach at 50 to 100 feet, on runway centerline, throughout the required zones. If the aircraft cannot be maintained on centerline for evaluation of zones 4 and 5 due to wind conditions, the evaluation may be conducted by taxiing the aircraft down centerline throughout zones 4 and 5.

NOTE: If structure appears to have deteriorated since the previous inspection, or if out-of-tolerance structure is found, verify the results of this check by flying the procedure listed in a(2)(a) above.

b. Zones to be inspected for structure. The inspection of localizer zones vary, depending upon the ILS category and/or the type of inspection that is being performed (see Section 301 and figure 217-1 for zone definition).

Type Approach/Facility	Zones to be Inspected
Category III	Zones 1, 2, 3, 4, 5
Category II ILS	Zones 1, 2, 3, and 4 (see paragraph 107.34)
Category I ILS and all other types of facilities or approaches	Zones 1, 2, 3

NOTE: During site, commissioning, reconfiguration, categorization, antenna, and/or frequency change inspection—check all of zone 1.

All other inspections (i.e., periodic, periodic with monitors, etc.) evaluate structure from GSI or the FAF (whichever is further) through all other required zones.

After Accident Inspections. See paragraph 104.51.

Category II localizers failing to meet structure tolerance in zone 4 will not be shown as restricted on the flight inspection report; however, a NOTAM will be issued. See paragraph 107.34.

c. Alignment Areas. Determine the course alignment in the following areas:

Front Course	From	To
CAT I, II, III	One mile from runway threshold	Runway thres-hold
ILS Zone 4	Runway thres-hold	Point D
ILS Zone 5	Point D	Point E
Offset Localizers	One mile from runway threshold	Runway threshold or abeam runway threshold
LDAs and SDFs	One mile from Point C	Point C
Back Course		
All Types of Facilities	Two miles from the antenna	One mile from the antenna

NOTE: When a restriction occurs in an area where alignment is normally analyzed, measure alignment by manually analyzing the average course signal in the following areas:

From	To
One mile from the start of the restriction.	The start of the restriction.

217.32071 Glide Slope Signal on Localizer Back Course. Evaluation of localizer back course approaches shall also include an evaluation for active glide slope signals. Glide slope signals that result in flag or CDI activity shall be cause for immediate action to alert pilots to disregard all glidepath indications on the back course approach (i.e., NOTAM). Ensure the alert will be printed on the localizer back course instrument approach chart.

217.3208 Monitor References. The inspector shall ensure that the facility is set at the monitor reference prior to each check. Monitors references shall be checked when prescribed by the checklist and when applicable on special inspections. When a facility is found operating out-of-tolerance, the monitor which should have sensed the out-of-tolerance condition shall be checked.

a. Alignment Reference. This check is performed to assure that the monitors will detect a specific shift of the localizer course.

(1) Approved Procedure—Front Course. It is not necessary to verify ground alignment monitor checks in the air or to verify airborne alignment monitor checks on the ground.

Request the course be misaligned to the monitor alarm limits each side (90 Hz/150 Hz) of the operational course. Both the recorder and the visual display shall be used to verify course alignment shifts. During any inspection, the monitor limits shall be referenced to the designed on-course alignment according to facility category.

(a) Ground. After the airborne localizer alignment has been determined, position the aircraft near the runway threshold where the stable crosspointer is received. The aircraft may be displaced as much as 75μA from the on-course signal. (This option is authorized, providing the sensitivity of the course sector width is linear.) The received course indication shall be referenced to the alignment found airborne. Request that maintenance shift the course to both of the monitor limit points and then return to normal.

At facilities that are installed offset to the runway, the alignment monitor limits may be established with the aircraft on the ground within 75μA of the on-course signal; but the aircraft shall not be positioned closer than 3,000 feet from the antenna array. If these two conditions cannot be met, perform this check in the air (see (b) below).

If facility alignment is adjusted on the ground before the monitor inspection and a misalignment is found during the airborne evaluation, a recheck is not required if the following criteria are met during the ground adjustment:

<u>1</u> In-tolerance flag/modulation and AGC exist.

<u>2</u> Crosspointer is stable.

<u>3</u> Crosspointer data are recorded as found during adjustment and at the final setting.

<u>4</u> All data are clearly labeled to reflect the adjustment(s) made.

(b) Airborne. Perform airborne alignment monitor checks while inbound on the designed procedural azimuth (on localizers aligned along runway centerline, the aircraft should be aligned with the centerline extended). Measure the alignment shifts to monitor limits by recording the instantaneous course displacements or course shifts as referenced to runway centerline extended. If feasible, this may be accomplished on one run during which both limit points and a return to normal are recorded.

(c) Equality of Modulation. When course alignment is satisfactory and a monitor inspection is required, localizers may be evaluated for monitor references using equality of modulation method. This method may be used on all categories of localizers with the concurrence of maintenance personnel. All facilities shall be flown to establish the alignment in a normal operating configuration. Once the alignment has been established, maintenance will set up an equality of modulation configuration. The equality used to establish the alignment will become the reference for the subsequent monitor readings. When requested, maintenance personnel will unbalance the modulation to achieve the monitor reference point. Measure the displacement in microamps, repeat the procedure in the other direction, then restore to normal. This may be accomplished in the air or on the ground and need not be performed on centerline. Use of this method will be noted in the remarks section of the flight inspection report.

(2) Approved Procedure—Back Course. This check may be accomplished on the back course using the procedures described in paragraph (b) above, or on the front course, as in paragraph (a) or (b) without the waveguide transmitter radiating.

b. Width Reference - Approved Procedure. Use the flight procedure and methods described in paragraph 217.3206.

217.3209 RF Power Monitor Reference. This inspection is conducted to determine that the localizer meets specified tolerances throughout the service volume while operating at reduced power.

a. Approved Procedure. This procedure applies to the front course (and the back course if it is used for an approach or missed approach).

This check shall be conducted with the facility operating at reduced power. Check for interference, signal strength, clearances, flag alarm current, identification, and structure as follows:

Steps:

(1) Fly an arc across the localizer course at 18 miles from the antenna (or ESV distance, whichever is greater), at 4,500 feet above site elevation (or ESV altitude, whichever is higher) throughout Sector 1.

(2) Repeat step one except fly across the localizer at the LCA.

(3) Proceed on course, inbound from 18 miles (or ESV, whichever is greater) maintaining the LCA to 10 miles.

(4) Fly an arc across the localizer course at 10 miles from the antenna at the LCA throughout sectors 1 and 2 (and 3, if procedurally required).

(5) Maintain the LCA and proceed in-bound on course until reaching 7 degrees above the horizontal (measured from the localizer antenna) or point C, whichever occurs last.

217.3210 Clearance. Clearances are measured to ensure that the facility provides adequate off-course indications throughout the service volume (or ESV, whichever is greater).

a. Approved Procedure. This check applies to the front course (and the back course if it is used for an approach or missed approach). The clearance orbit will be conducted at a radius between 6 to 10 miles from the antenna at the LCA. After commissioning, higher altitudes may be used, provided a comparability check is made (usually at commissioning) at the LCA and the higher altitude. The results at the higher altitude are the same or more restrictive (e.g., clearances lower). This comparison shall be documented on the data sheet. Clearances shall be rechecked at the LCA following any modifications or adjustments to the localizer (wide alarm) or when environmental changes occur.

(1) Check Sectors 1 and 2. Check Sector 3 if it is required to support a transition. Check only that portion of the arc in Sector 3 on the side of the course which contains the transition.

(2) A course used exclusively for missed approach guidance and/or a fix shall meet clearance tolerances in Sector 1.

(3) Use event marks to accurately identify the 10 degree, 35 degree, and when necessary, the 90 degree azimuth from the published localizer azimuth to assist in interpreting and orienting the recording. If the results of an orbit/arc indicate less than minimum clearance, adjustments shall be made to correct the low clearance condition. When adjustments are made, recheck course width, modulation, and alignment.

b. Inspections.

(1) Monitor Reference Evaluations. Check clearances in the monitor limit configurations described in the appropriate checklist. It is not necessary to check clearances in the normal configuration if the clearances found during the monitor checks are equal to or greater than the tolerances required for normal.

(2) Commissioning. Check clearances in both the normal and the monitor limit configuraions described in the appropriate checklist.

217.32101 High Angle Clearance. This check determines that the transmitted signals provide proper off-course indications at the upper limit of the service volume. Conduct this check during a site evaluation, commissioning inspection, or when a change in location, height, or type of antenna is made.

Approved Procedure. This check applies to the front course (and the back course if it is used for an approach or missed approach). This check is only required on one transmitter.

a. Fly a 10-mile arc through Sectors 1 and 2 (and 3, if procedurally required), at 4,500 feet above the antenna (or ESV, whichever is greater).

b. If clearances are out-of-tolerance, additional checks will be made at decreasing altitudes to determine the highest altitude at which the facility may be used.

217.3211 Coverage. Coverage shall be evaluated concurrently with each required check during all inspections.

217.3212 Reporting Fixes, Transition Areas, SIDs STARs, and Profile Descents. Refer to Figure 217-2. The localizer, SDF, or LDA may be used to support fixes, or departure, en route, and arrival procedures. Transitions may be published through air space which are beyond the localizer, SDF, or LDA service volume. Under these circumstances, navigation is accomplished by using some other facility such as VOR or an NDB. Facility performance of all facilities involved shall be checked to ensure that all coverage parameters are within tolerance. This shall be done during a commissioning inspection, when new procedures are developed or redescribed, or on appropriate special inspections (e.g., user complaints).

Approved Procedure. This check applies to the front course (and the back course if it is procedurally used). The facilities (Localizer and/or Glide slope) shall be checked in RF power alarm.

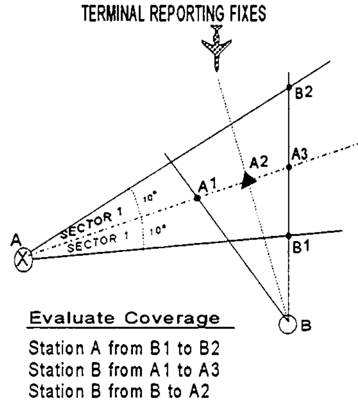
(1) Fixes. If the localizer is used for a cross course fix indication, it shall satisfy coverage tolerances in Sector 1 on both sides of the localizer on-course. In addition, check the on-course signal throughout the fix displacement area. Conduct these checks at the minimum authorized altitude.

(2) Transitions. When a transition (or missed approach routing) is designed to traverse localizer course Sector 3 or air space which is outside the commissioned service volume and the transition termination point is not identified with a facility other than the localizer course (e.g., compass locator, lead radial, etc.), check clearance and coverage throughout the entire transition air space at the minimum authorized altitudes.

(3) SID's. Check on-course structure throughout the area of intended use. Check clearance in Sector 1 at the termination point at the minimum authorized altitude.

(4) STARs and Profile Descents. Fly these procedures as proposed or as published. Check facility performance when checking STARs and profile descents in accordance with paragraphs (1) and (2) above, with fixes.

Figure 217-2



217.3213 Polarization Effect. The purpose of this check is to determine the effects that vertical polarization may have on the course structure.

Approved Procedure. This check applies to the front course (and the back course if it is procedurally used), and may be accomplished concurrently with the course structure check. This check is only required on one transmitter.

Fly inbound on-course at a distance between 12 and 6 miles from the facility and roll the aircraft to a 20-degree bank left and right. Actuate the event mark at the maximum banked attitude.

217.3214 Identification and Voice. This check is made to ensure identification and voice (if installed) are received throughout the coverage area of the localizer. See paragraph 217.3211.

SDFs have a three-letter coded identifier. Localizers and LDAs have a three-letter coded identifier preceded by the code letter I.

Approved Procedure. This procedure is applicable to the front course (and the back course if it is procedurally used).

Record the identification during all checks. Check voice transmissions when on-course at the LDA, the maximum distance at which course structure is being evaluated.

A localizer shall be restricted if identification cannot be received in all areas of required coverage.

A localizer shall not be restricted solely because the voice/ATIS cannot be received. In this event, advise the procedures specialist and/or air traffic operations personnel.

217.33 Detailed Procedures—Glide Slope.

217.3301 Spectrum Analysis. Reserved.

217.3302 Modulation Level. This check measures the modulation of the radiated signal.

Approved Procedure. Measure the modulation of the glidepath while inbound on the localizer/ glidepath course between 7 and 3 miles from the glide slope antenna with a signal strength of 150 µV or greater.

217.3303 Modulation Equality. This check establishes the balance of the carrier signals. This check should be made prior to any phasing checks and will be used as the reference for phasing.

Approved Procedure. Have maintenance personnel configure the facility to radiate carrier signal only. When checking capture effect facilities, the primary transmitter radiates this configuration while the clearance transmitter is off or in dummy load.

Use the procedure described in paragraph 217.3302, Modulation Level. While descending, call out the balance as read on the precision micrometer to facilities maintenance personnel. Zero µA is optimum. An imbalance in excess of 5µA shall be adjusted towards optimum.

217.3304 Phasing. This check determines that the correct carrier and sideband-only phase relationship are distributed to the antennas.

a. Approved Procedure. Phasing may be performed on the ground (by maintenance) or in the air. Consult the appropriate checklist in paragraph 217.3101. Proceed inbound 8-10 miles from the glide slope antenna along the localizer on-course, preferably at 1,000 feet above glide slope site elevation. Altitude may vary with terrain to provide line of sight. The flight inspection technician should relay the microammeter indications to the facilities maintenance personnel.

Maintain the level run and have maintenance adjust the phaser until the crosspointer is the value found during the modulation equality check. Upon reaching a point 1/3 to 1/2 of the glidepath angle, commence a descent. Maintain this angular descent until reaching runway threshold. Do not make facility adjustments inside 4 miles during the angular descent. Record crosspointer throughout the phasing run.

(1) Analysis of Phasing Results. Analyze the crosspointer trace during the descent portion of the maneuver. Make additional phasing adjustments as needed until the average crosspointer during the descent portion average the same value found during the modulation equality check.

If the microammeter value varies from the average during the descent between 1/2 mile from the threshold and runway threshold, the antenna offset may be incorrect and should be checked (antenna offset is most accurately established and set by maintenance).

(2) Maintenance Coordination. A comparison of airborne and ground phasing data should be made by maintenance personnel in order to determine if optimum phasing has been established.

b. Null Reference Phasing Make the following checks and phase the facility in the configurations listed below:

Sidebands Radiating in Quadrature to Carrier. Perform the maneuver described in paragraph 217.3304a, Phasing.

c. Sideband Reference Phasing. Make the following checks and phase the facility in the configuration listed below:

(1) Upper Antenna Feed in Dummy Load. Have facilities maintenance personnel insert a 90-degree section in the main sideband line. Conduct a level run at 1,000 feet above site elevation between 10 to 5 miles from the glide slope antenna. Adjust the phaser to the value found during the modulation equality check.

When phasing is completed, remove the 90-degree section and check for fully fly-down signal. This indicates that the lower antenna sensing is correct. If full fly-up signal is indicated, sensing is incorrect and the facility must be adjusted.

(2) Radiate Upper and Lower Antennas with a 90-degree Section in the Main Sideband Phaser. Use the procedure described in paragraph 217.3304a, Phasing. Have maintenance adjust the upper antenna phaser to the value found during the modulation equality check. When this value is attained, remove the 90-degree section from the main sideband line. Ensure that a fly-up signal is received when the aircraft is below the glidepath.

d. Capture Effect. Capture effect glide slopes are normally phased on the ground by maintenance personnel; however, they may request airborne phasing. The airborne phase verification procedure shall be accomplished when requested by maintenance. This procedure confirms that correct phasing has been achieved.

(1) Airborne Phase Verification Procedure. This procedure helps maintenance to determine if proper phasing exists. Both transmitters may be checked if standby equipment is installed.

Airborne Phase Verification Procedures

Steps	Checks	PARAMETER Modulation	Width	Angle	Symmetry	Structure Below Path	Clearance	Path Structure
(a)	Modulation	X						
(b)	Modulation Equality	X						
(c)	Normal Configuration	X	(1)	(2)	X	X	(6a)	X
(d)	Main Sideband Phaser Dephased							
	Advance*		(3)	(4)		X		
	Retard*		(3)	(4)		X		
(e)	Middle Antenna Phaser Dephased							
	Advance*		(3)	(5)		X	(6b)	
	Retard*		(3)	(5)		X	(6b)	
(f)	Normal	X	X	X		X		

FOOTNOTES:

(1) Adjust glidepath width to 0.70° ± 0.03°.
(2) Facility will be adjusted to within 0.05° of commissioned angle.
(3) Width— 0.1° sharper or 0.2° wider than normal.
(4) Angle—± 0.1°.
(5) Angle—± .05°.
(6) Clearance—At a fixed angle of 1.0° from 4 miles to runway threshold.
If obstruction clearance is a limiting factor, an acceptable higher fixed angle may be used.
(a) 180 μA or better.
(b) 150 μA or better

Footnotes (3), (4), (5), and (6) are not tolerances; they are results which are expected.

* Actual degrees advance or retard to be determined by maintenance.

(2) Airborne Phasing. When airborne phasing is requested, use the procedure described in paragraph 217.3304d(s)(a) or (b) below, or other alternate procedures specified by maintenance. Facilities maintenance personnel shall determine which procedure is to be used.

(a) Airborne Phasing Procedure No.1. Confirm that maintenance has established normal carrier sideband ratios and that ground phasing is complete.

NOTE: The clearance transmitter is de-energized throughout steps (1)-(4).

Airborne Phasing Procedure No. 1

Steps	Type Check	Reference Paragraph	Configuration	Unit of Interest
(1)	Modulation Level	217.3302a	Carrier Only	In Tolerance
(2)	Modulation Equality	217.3303a	Carrier Only	Crosspointer 0μA ± 5μA
(3)	Phasing	217.3304a	Upper to Middle Antenna Lower Antenna—Dummy Load Middle Antenna—Radiate Carrier + Sidebands Upper Antenna—Radiate Sidebands Main Sideband Phaser—Quadrature	Crosspointer centered about the value found in step (2).
(4)	Phasing	217.3304a	Lower to Upper and Middle Antenna Lower Antenna—Radiate Carrier + Sidebands Middle Antenna—Radiate Carrier + Sidebands Upper Antenna—Radiate Sidebands Main Sideband Phaser—Quadrature	Same as above.
(5)	Phase Verification	217.3304d(1) Steps (c)-(f)		

(b) Airborne Phasing Procedure No. 2. This procedure only applies to those facilities in which it is possible to separate carrier and sideband signals in the APCU (Amplitude and Phase Control Unit). Confirm that facilities maintenance personnel have established normal carrier sideband ratios and that ground phasing is complete.

NOTE: The clearance transmitter is de-energized throughout steps (1)-(4).

Airborne Phasing Procedure No. 2

Steps	Type Check	Ref. Para.	Configuration	Unit of Interest
(1)	Modulation Level	217.3302a	Carrier Only	In Tolerance
(2)	Modulation Equality	217.3303a	Carrier Only	Crosspointer 0uA±5uA
(3)	Phasing	217.3304a (See note a below)	*Lower to Middle Antenna Phasing* Lower Antenna - Radiate Carrier Only Middle Antenna - Radiate Sidebands Only Upper Antenna - Dummy Load Main Sideband Phaser - Quadrature	Crosspointer Centered about the value found in step (2)
(4)	Phasing	217.3304a (see note b below)	*Lower to Upper Antenna Phasing* Lower Antenna - Radiate Carrier Only Middle Antenna - Dummy Load Upper Antenna - Radiate Sidebands Only Main Sideband Phase - Quadrature	Crosspointer Centered about the value found in step (2)
(5)	Phase Verification	217.3304d(1) Step (c) - (f)		

NOTE: a) Step (3) phasing runs should be accomplished at an elevation angle of 1/2 the glidepath angle (or up to 2/3 of the angle if terrain prevents the lower angle.)

b) Step (4) Phasing runs should be accomplished at an elevation angle equal to the glidepath angle.

217.3305 Engineering and Support Tests. These tests are made at maintenance request, on one transmitter only. Their purpose is to assist the facilities maintenance personnel to make measurements that they are not able to make and/or confirm from the ground.

217.33051 Null Check. The antenna null check is an engineering support check and is not conducted unless requested by engineering/ maintenance personnel. This check is conducted to determine the vertical angles at which the nulls of the individual glidepath antennas occur. It can be conducted on all image array systems. No procedures exist for the non-image arrays.

a. *Approved Procedure.* Use one of the level run methods described in paragraph 217.3306a(1), while the facility is radiating carrier only (sidebands dummy loaded) from one of the antennas. A level run and analysis shall be made for each antenna.

b. Analysis. Compute the angles from the nulls which appear on the recording as dips in the AGC. If the AGC dips are broad, as in the case of the first null of the upper antenna of a capture effect glide slope, angle measurements may have to be accomplished by measuring the second and/or third null.

217.33052 Antenna Offset. This check is performed to establish the horizontal antenna displacements on the mast. Offset affects the phase relationship of the glidepath signal as the aircraft approaches the runway threshold. Low clearances, and/or a fly-down signal between Point B and the runway threshold may be caused by improper offset. Antenna offsets can be accurately determined and positioned by facilities maintenance personnel without flight inspection assistance.

Approved Procedure. Perform a phasing check in accordance with paragraph 217.3304. After optimum results are achieved in the far field (1/2 mile from the runway threshold and beyond), park the aircraft on centerline at the runway threshold. With the facility still in quadrature phase, have facilities maintenance personnel adjust the horizontal displacement in the antennas (the top most antenna should be closer to the runway than the bottom). As the antennas are being adjusted, relay crosspointer indications to the facilities maintenance personnel. The optimum setting is the same as the displacement found during the quadrature phasing checks. Take a final reading when the antenna is secured and personnel are not on the mast. Check the effects of the antenna offset adjustment in the far and near fields by performing another phasing check (217.3304).

NOTE: If the crosspointer is not stable when the aircraft is parked at the runway threshold, then the antenna offset cannot be established on the ground. In this case: (1) have maintenance readjust the antenna offset based on the final phasing run; (2) re-fly the last 3000' from the runway threshold in accordance with paragraph 217.3304a; (3) analyze the results based on paragraph 217.3304a(1).

217.33053 Spurious Radiation. This check is performed to determine if any glide slope signal exists in the final approach segment with the facility configured in dummy load.

Approved Procedure. Fly a low approach on runway centerline, commencing at least 4 miles from the facility. Using a spectrum analyzer and the analog record, compare any signals that are received during the approach with the results found while the facility is transmitting normally.

217.3306 Angle Width, Symmetry, and Structure Below Path. These parameters may be measured from the results of one level run, except when the actual path angle is required (for specific ILS categories and on various types of inspections). In this case, determine the angle by the actual path angle method.

a. Angle. Two methods are used to determine the glidepath angle. They are the level run method, paragraph 217.3306a(1) and the actual path angle method, paragraph 217.3306a(2). The actual path angle method shall be used to measure the path angle during site, commissioning, after-accident inspections, special inspections at maintenance request, and confirmation of out-of-tolerance conditions for Category I glide slopes. It shall also be used during any inspection to determine the reported angle for Category II and III glide slopes. The level run method may be used for measuring the glidepath angle of CAT I facilities subsequent to the commissioning inspection. It should be used for measuring the glidepath angle during monitor checks (for any ILS category), engineering support checks, etc.

NOTE: During any inspection in which actual path angle is measured, the angle found on the level run, in normal configuration, shall be compared to the actual path angle. The difference between these angles shall become a correction factor that shall be applied to all subsequent angles determined by the level run method. Where actual path angle is greater, add the difference to the level run angle; where actual path angle is less, subtract the difference from the level run angle.

Prior to beginning a site or commissioning inspection, obtain the commissioned angle from ground/procedures personnel. Do not change it without their concurrence.

(1) Approved Procedures--Level Run. Position the aircraft beyond the 190uA/150Hz glidepath point on the localizer on-course or procedural designed azimuth. Maintain a constant airspeed. The altitude selected for the level run is usually the GSI corrected to true altitude. However, the selected or GSI altitude may be adjusted due to ATC request, weather, unmeasurable crosspointer transitions, comparability to actual path angle, or a lower altitude to obtain 190uA.

(a) Theodolite Method. Position the theodolite or tracking device in accordance with paragraph 217.25, Theodolite Procedures. Proceed inbound recording 1020Hz reference marks from the theodolite. Measure width, angle, symmetry, and structure below path by referencing the recording at the 190uA/150Hz, 75uA/150Hz, on path, 75uA/90Hz points with the theodolite 1020Hz marks which are usually spaced at 0.2^{o} intervals.

NOTE: An RTT may be used to track an aircraft through the path sector. Apply the path sector width received to the calibration of the RTT.

(b) Altimeter and Ground Speed Method. Fly inbound. Mark checkpoints with the event mark and identify them on the recording. Checkpoints are normally the outer marker and the glide slope antenna; however, any two checkpoints separated by a known distance may be used. A distance for each point (i.e., 190uA, 75uA, 0uA, and 75uA) is determined by using time/distance ratios. The appropriate angle, width, symmetry, and structure below path are calculated from these values.

(c) Manual Mode Method. Fly inbound. Annotate the aircraft's ground speed and altitude along the track at 190uA/150Hz, 75uA/150Hz, on path 75uA/90Hz points on the recording. Compute individual angles from this data and determine glidepath angle, width, symmetry, and structure below path.

(2) Approved Procedures--Actual Path Angle.

(a) RTT Method. Determine the actual path angle from the straight line arithmetic mean of all deviations of the differential trace occurring in ILS Approach Zone 2. The arithmetic mean can be determined either by using a compensating polar planimeter or by averaging 2-second samples of the deviations in Zone 2 (smaller sampling interval may be used, e.g., 1-second samples).

(b) Standard Theodolite Method. Sufficient positioning information must be obtained to determine the actual path angle, and the presence of bends, reversals, and shorter term aberrations; therefore, more than one run may be required.

b. Width. Path width is the width in degrees of the glidepath width sector. Path width measurements are obtained from level runs (see 217.3306a(1)).

Some facilities have step characteristics of the crosspointer transition which may preclude the use of the 75uA points. If this occurs, determine the path width of the facility between points other than 75uA (maximum 90uA, minimum 60uA). The path width shall be determined by proportioning the value obtained at the selected points to 75uA.

If a point other than 75uA is used to measure path widths, that point shall be used on all subsequent checks and inspections.

c. Symmetry. Symmetry is determined from the data obtained during level run angle and/or width measurements. If points other than the 75uA points are used for measuring the path width, they shall also be used for the symmetry measurements. Symmetry is the balance of the 2 sectors, 90Hz/150Hz. The glidepath should be as symmetrical as possible; however, there normally is some imbalance.

When a facility exceeds the specified tolerance and cannot be adjusted, additional measurements shall be made 200 feet above GSI altitude, and 200 and 400 feet below GSI altitude. If the average of the 4 measurements is within tolerance, the facility may be left in service. If the average is not acceptable, the AFIS, RTT, or theodolite shall be used to determine the mean symmetry (see paragraph 217.3308, Mean Width). If the mean symmetry still remains out-of-tolerance, the facility shall be removed from service.

d. Structure-Below-Path. This check determines that the 190uA/150Hz point occurs at an angle above the horizontal which is at least 30 percent of the commissioned angle. The structure below path is determined from the data obtained during the level run angle or width measurements. Altitudes lower than GSI may be required to make this measurement.

NOTE: The structure-below-path point does not have to occur within the service volume of the facility to be a valid check, provided the AGC and flag alarm current indications are within appropriate tolerances.

If the 190uA/150Hz point, in any facility configuration, cannot be found, conduct a clearance below path check starting at the edge of the service volume. Apply the appropriate tolerance.

217.3307 Clearance. This check is performed to assure that positive fly-up indications exist between the bottom of the glidepath sector and obstructions. Clearances above the path are checked to ensure that positive fly-down indication is received prior to intercepting the first false path.

a. Approved Procedure.

(1) Clearance Below the Path. Fly along the localizer on-course (or the areas specified by the checklist). Check that the required amount of fly-up signal (180uA in normal, 150uA in any alarm condition) provides adequate obstacle clearance between the FAF or GSI, whichever is further, and:

CAT I - ILS point "C" for an unrestricted glide slope; or the point at which the glide slope is restricted.

CAT II and III - Runway threshold.

(2) Clearance Above the Path. Check that 150uA fly-down occurs prior to the first false path. Perform this check during the level runs in accordance with the approved procedure, paragraph 217.3306a(1).

217.3308 Mean Width. This check, performed during site evaluation, commissioning, and reconfiguration inspections, is used to determine the mean width of a glidepath between ILS Points "A" and "B". This check may also be used to determine the mean symmetry of the glidepath. Theodolite, RTT, or AFIS shall be used. The path width should be established, as nearly as possible, to 0.7° prior to the check.

Approved Procedure. Fly inbound on the localizer on-course maintaining 75uA above the glidepath between ILS Point "A" and "B". Repeat the same run at 75uA below the glidepath, and again while on the glidepath.

Determine the mean width from the angle found above and below the glidepath and calculate symmetry from the on-path angle.

217.3309 Tilt. This check verifies that the glidepath angle and clearances are within the authorized tolerance at the extremities of the localizer course sector.

Approved Procedure. With the glide slope facility in normal, measure clearances below the path at each extremity of the localizer course sector from the GSI to point B. In addition, measure the path angle and clearance above the path on each side of the localizer course at the GSI using the level run method. This check is only required on one transmitter.

217.3310 Structure and Zone 3 Angle Alignment. These checks measure structure deviations and zone 3 angle alignment. Measurements are made while the facility is operating in a normal configuration, except for special structure evaluations on waveguide facilities.

a. ***Approved Procedure.*** Fly inbound on the glidepath and localizer course from 10 miles from the glide slope antenna or glide slope ESV (whichever is greater) through all zones. The structure shall be evaluated in all zones and the category (CAT) II and III angle alignments in zone 3. Angle alignment shall be evaluated using the RTT or AFIS.

b. Inspections.

(1) During site, commissioning, reconfiguration, categorization, antenna, and/or frequency change, evaluate the structure by using the entire procedure described in paragraph a above.

(2) During all other inspections (i.e., periodic, periodic with monitors, etc.) this evaluation can be accomplished from the GSI or FAF (whichever is further) by using the procedure described in paragraph a above.

217.3311 Transverse Structure--Endfire Glide Slope. This is a measurement of the horizontal structure of the glidepath at the FAF distance, between 8^{0} each side of the localizer on-course.

a. Approved Procedure. Fly an arc at a radius equal to the distance from the localizer antenna to the FAF, but no less than 5.0 miles from the glide slope antenna, at the FAF altitude corrected to true altitude. Record both localizer and glide slope crosspointers: Localizer crosspointer Cal 400uA and glide slope crosspointer Cal 400. For engineering support, use localizer crosspointer Cal 400 uA and glide slope crosspointer Cal 150 uA. The arc may be flown either clockwise or counter-clockwise.

b. Analysis. No tolerance is applied to transverse structure, but the following results are expected. Results exceeding the expected values will require engineering analysis prior to final resolution.

(1) Within the localizer course sector, the change of the glide slope signal should not exceed plus or minus 48uA from the crosspointer value found on the localizer on-course.

(2) From the edge of the localizer course sector to 8^{0} from the localizer on-course, signals should not exist that are greater than 48uA in the 90 Hz direction from the glide slope crosspointer value found on the localizer on-course.

c. Structure Below Path. A transverse structure check at 0.7^{0} below the established glide angle is required on commissioning. The information is necessary for maintenance to properly adjust the antenna system.

217.3312 Coverage. Coverage shall be evaluated concurrently with each required check during all inspections.

217.3313 Monitors. The purpose of these checks is to measure glidepath parameters when the facility is set at the monitor limit condition. The inspector shall ensure that the facility is set at the monitor limit prior to each check. Monitors shall be checked when prescribed by the checklist, and when applicable on special inspections. When a facility is found operating out-of-tolerance, the monitor which should have sensed the out-of-tolerance condition shall be checked and reset.

At the conclusion of any monitor inspection, the facility shall be returned to normal, and the following checks performed and results reported: Angle, Width, Symmetry, and Structure Below the Path, 217.3306.

a. ***Approved Procedure.*** Use the level run method (paragraph 217.3306a(1)) to measure width, angle, and structure below the path in the monitor limit conditions. Check clearances in accordance with 217.3307.

b. Inspections--Periodic with Monitors. There is no requirement to check the facility in normal prior to conducting the monitor check.

217.3314 RF Power Monitor Reference. This check is conducted to determine that the glide slope meets specified tolerances throughout its service volume while operating at reduced power.

a. ***Approved Procedure.*** The glidepath transmitter shall be placed in reduced power setting for this check (both primary and clearance transmitters for capture effect and endfire glide slopes). This check shall be made on the localizer on-course and 8^{0} on each side of the localizer on-course.

While maintaining the LCA, fly inbound from 10 miles from the facility, or ESV (whichever is further), to the interception of the lower sector of the glidepath (i.e., the point nearest the glidepath at which 150 uA occurs). Fly through the glidepath sector and check clearances above the path.

The endfire glide slope antenna array is orientated toward the runway. The normal fly-up/fly-down signal ends at approximately 5^{0} on the antenna side of the runway; therefore, you will have only 150 Hz clearance signal at 8^{0} on the antenna side of the runway. The provisions of paragraph 217.44 will apply to this situation.

In situations where the GSI intersects the glidepath at a distance that provides less than 150uA fly-up signal, descend to an altitude which will provide at least 150 uA fly-up while providing adequate obstacle clearance at 10 miles or ESV (whichever is further).

217.34 General.

217.3401 Standby Equipment - Localizer/ Glide Slope. Where dual equipment is installed, complete all checklist items for both sets of equipment, except as noted in the text of this section, and the checklists.

217.3402. Standby Power - Localizer/Glide Slope. Refer to paragraph 106.43; if the check is required, make the following checks while operating on standby power.

a. Localizer. Course width, alignment, symmetry, modulation, and identification.

b. Glide Slope. Modulation, width, angle, symmetry, and structure below the path.

217.3403 Expanded Service Volume (ESV). Where an operational requirement exists to use either or both the glide slope and localizer to altitudes and/or distances beyond the normal service volume, the facility(ies) shall be inspected to the expanded altitudes and/or distances (in accordance with 217.3209 and 217.3314) to determine that facility performance for the required parameters meets tolerances. Place particular emphasis on signal strength, interference, clearances, and structure.

If a localizer or glide slope cannot support ESV requirements, the ESV shall be denied. The facility shall not be classified as restricted solely because it fails to support the ESV.

217.35 Supporting NAVAID's. These may consist of marker beacons, a compass locator, DME, and/or lighting systems. Additionally, some locations may require other types of NAVAID's to support the approach procedures.

217.36 Instrument Flight Procedures. See Section 214.

217.4 Analysis. A detailed analysis of the measurements and calculations made during the course of the flight inspection provides an overall picture and permanent record of facility performance.

217.41 Application of Localizer/Course/Glide-path Structure Tolerances. Application of course structure analysis contained in this paragraph applies to all zones (1, 2, 3) of glidepaths and all zones of localizers (1, 2, 3, 4, & 5) and SDF's, including back courses. This application does not apply to site, commissioning, or categorization inspections. Refer to Figure 217-3. If course or path tolerances are exceeded, analyze the course/path structure as follows:

a. Where course/path structure is out-of-tolerance in any region of the approach, the flight recordings will be analyzed in distance intervals of 7,089 feet (1.17 NM) centered about the region where the out-of-tolerance or aggregate of out-of-tolerance condition(s) occurs. Two 7,089 foot areas will not overlap.

b. Where necessary to avoid overlap, centering the interval about the out-of-tolerance region may be disregarded.

c. It is not permissible to extend the 7,089 foot segment beyond the area checked, i.e., service volume or ESV, whichever is greater, or the point closest to the runway where analyzation stops.

d. The course/path structure is acceptable if the aggregate structure is out of tolerance for a distance equal to or less than 354 feet within each 7,089 foot segment.

NOTE: This application shall not apply to site or commissioning inspections.

217.42 Rate of Change/Reversal in the Slope of the Glidepath. The following analysis of the path angle recording shall be accomplished during all inspections where AFIS, RTT, or other tracking devices are being used. It applies to all categories of ILS.

a. Inspect the glidepath corrected error trace/differential trace in zones 2 and 3 for changes and/or reversals in the trend of the slope of the path trace.

b. Determine if the trace (or trend), on either or both sides of the point where a change in direction occurs, extends for at least 1,500 feet along the approach with an essentially continuous slope (see Figure 217-4).

c. If one or more changes/reversals meets the condition in b. above, draw a straight line through the average slope that covers at least a 1,500 foot segment each side of the point of change. It is permissible to extend the straight line of the average slope to inside Point C if required, in order to obtain the 1,500 foot segment. Determine the change-in-slope by measuring the divergence of the two lines at a point 1,000 feet from their intersection.

d. NOTAM Action. Facilities which do not meet this tolerance shall be restricted by a NOTAM that withholds authorization for autopilot coupled approaches below an altitude (MSL) which is 50 feet higher on the glidepath than the altitude at which the out-of-tolerance condition occurs. Compute the MSL altitude for such a restriction based on the commissioned angle of the facility. Advise the appropriate procedures specialist.

(1) Category II and III facilities are required to meet the established change/reversal criteria for that portion of the glidepath which is between the published GSI and Point C. The facility shall be classified as restricted if a change/reversal is found.

(2) Category I facilities should meet this change/reversal criteria. Category I facilities which do not meet this tolerance shall not be classified "restricted" if a change/reversal is found; however, NOTAM action shall be taken (see paragraph 107.24).

217.43 Application of Localizer Coverage Requirements. The maneuvering areas described in the approved procedures of this section define the standard service volume in which coverage tolerances shall be maintained in order for a localizer to be assigned a facility classification of "UNRESTRICTED". The localizer may still be usable when coverage does not meet tolerances throughout the standard service volume, depending on the effect of the restriction on procedural use. In evaluating such effects, all coverage criteria must be considered; however, for an UNRESTRICTED classification, the following criteria must also be met:

a. Clearances

(1) Tolerance Application. Deviations in any sector to less than 100 uA are not acceptable. Deviations in Sector 1 to less than the tolerance are not acceptable. In Sectors 2 and 3, momentary deflections of the crosspointer to less than the tolerances are acceptable, provided that the aggregate area does not exceed 3° of arc in Sectors 2 and 3 combined in one quadrant. Such an area is acceptable on both sides of the localizer. Additionally, all the above criteria are applicable to the back course.

NOTE: One quadrant is defined as that area between the localizer on-course and a point 90° to the antenna.

(2) Restrictions. If a localizer is restricted in Sector 2, it shall not be used for a procedure turn on the restricted side, unless the inbound procedure turn course guidance is provided by some other facility, such as a VOR, NDB, etc.

b. Distance Requirements.

(1) Restrictions to localizer coverage at distances less than the standard service volume are permitted, provided the localizer meet all coverage tolerances throughout all procedural approach segments and at the maximum distance at which the procedure turn may be completed.

(2) Restrictions above the LCA are acceptable, provided a step-down fix, etc., can be added to the appropriate approach segment which restricts descent to within the altitude/distance at which acceptable coverage at the LCA was achieved.

c. Vertical Angle Requirements.

(1) If in-tolerance coverage cannot be maintained up to 7° or point C as required by step 5 in the RF power monitor check, the localizer may still be used for CAT I and nonprecision operations on a restricted basis; however, the localizer shall be classified as "unusable" if in-tolerance coverage cannot be maintained up to 4° or 1° greater than the commissioned glidepath angle, whichever is greater (both measured from the localizer).

(2) If vertical angle coverage is limited but the localizer can be used on a restricted basis as outlined above, a NOTAM shall be issued which restricts the localizer as "unusable" above a specified altitude, both at the threshold and at least one other point, usually the FAF (see example in Section 107). Note the angle at which unsatisfactory coverage occurred and evaluate its effect on the nonprecision MDA, maximum holding altitudes, and missed approach instructions/ protected areas.

217.44 Application of Glide Slope Coverage Requirements. The RF Power Monitor check described in paragraph 217.314 defines the lateral and longitudinal standard service volume of the glide slope. Although there is no specified tolerance, the approved procedure specifies to check for clearances above the path. If there is no defined glidepath or clearance above path, the glide slope shall be restricted as unusable beyond the point at which no glidepath or clearance above path is provided. See an example in Section 107. The glide slope shall meet the tilt tolerance and the RF power monitor tolerance.

217.45 ILS Maintenance Alert. Facilities serving the National Airspace System (NAS) and U.S. Air Force facilities not serving the NAS shall be provided an ILS maintenance alert as follows:

a. An ILS maintenance alert shall be provided by flight inspection following a normal periodic check without monitors when a measured flight inspection parameter exceeds 60 percent of the flight inspection tolerance. This applies to the following critical monitored parameters:

(1) Localizer course widths

(2) Localizer alignment

(3) Glide slope path widths

(4) Glide slope angles (except CAT III)

b. The flight inspector shall forward the ILS maintenance alert results by FAX or telephone (when FAX is unavailable) to the central scheduling and dispatch facility. The central scheduling and dispatch facility shall enter the results on FAA Form 8240-7-1, Appendix 11, FAA Order 8240.36 (current version) and forward the results by FAX or telephone (when FAX is unavailable) to the regional maintenance engineering branch within 24 hours. For U.S. Air Force facilities, notify the appropriate Major Command (MAJCOM) headquarters. When the results are forwarded by telephone, enter the name of the person contacted in the remarks block on FAA Form 8240-7-1, which shall be forwarded to the regional maintenance engineering branch.

c. When a measured flight inspection parameter exceeds the flight inspection tolerance, if AF maintenance is available and on site, request an evaluation of the parameter that has exceeded tolerance and determine whether it can be corrected. If the parameter that exceeded tolerance is corrected, leave the facility in service. If not, remove the facility from service and issue a NOTAM.

217.46 Glide Slope Snow NOTAM. During periods of heavy snow accumulation, Airway Facilities personnel may NOTAM glide slope facilities as "due to snow on the XXX (appropriate identifier), glide slope minima temporarily raised to localizer only." Category II/III operations are not authorized during the snow NOTAM. The following guidance is to be followed when an ILS is scheduled for a periodic inspection when a snow NOTAM is in effect and the flight inspection window is exceeded. Localizer flight checks shall be conducted as normally scheduled. Glide slope flight checks shall be accomplished dependent upon the following conditions:

a. If the NOTAM indicates localizer only for all categories of aircraft, then an approach evaluation shall be made to determine angle and structure. All out-of-tolerance conditions shall be reported to maintenance. After the snow NOTAM is canceled, flight inspection of the glide slope will be in accordance with paragraph 105.2. Enter "PI" in Block 22, Type of Check, on FAA Form 4040-5, Flight Inspection Daily Flight Log. In the "Remarks" section of FAA Form 4040-5, indicate, "Snow NOTAM in effect at time of inspection, no discrepancy assigned."

b. If the NOTAM indicates glide slope minima raised to localizer only for Category D aircraft, follow the procedure outlined in paragraph 217.46 above--the only exception being that any out-of-tolerance condition shall generate a discrepancy and the appropriate NOTAM. Restoration flight check shall be scheduled as an "Unscheduled Special (U)."

c. If the glide slope supports Category II/III approach procedures, the glide slope will only be evaluated to Category I tolerances. Restoration of Category II/III facilities, after the snow NOTAM is removed, will be considered as a periodic overdue inspection in accordance with paragraph 105.2.

d. Monitor check shall not be accomplished while the snow NOTAM is in effect. Flight inspection after the snow NOTAM is canceled shall be considered as a periodic overdue in accordance with paragraph 105.2.

e. If the approach is satisfactory, a Category I periodic check will be complete when a level run to check width and symmetry is accomplished and no out-of-tolerances are found. Entries on FAA Form 4040.5 shall be normal.

Figure 217-3

APPLICATION OF STRUCTURE TOLERANCE -- CAT. II & III

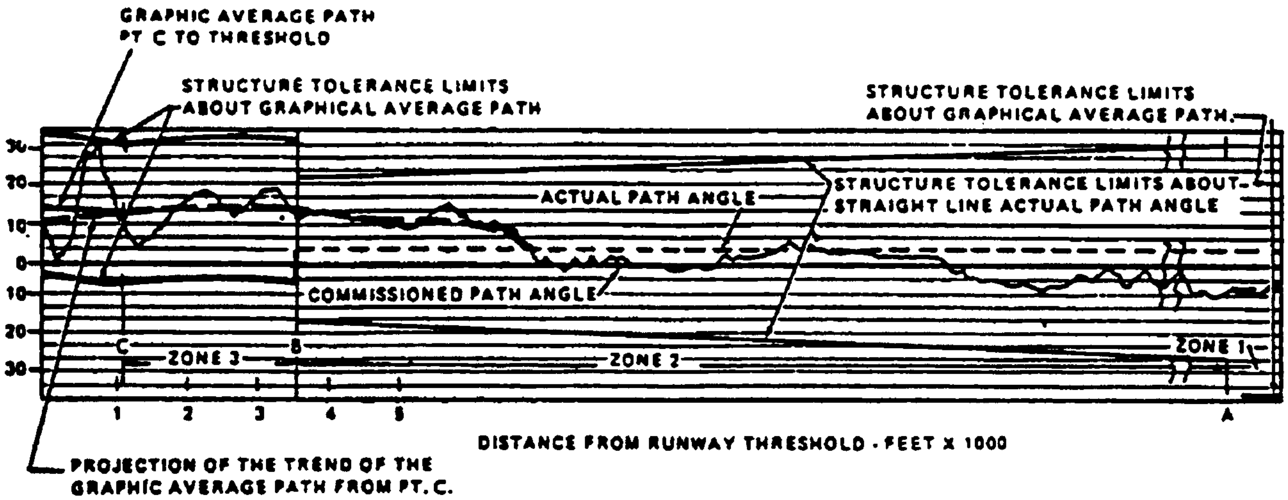
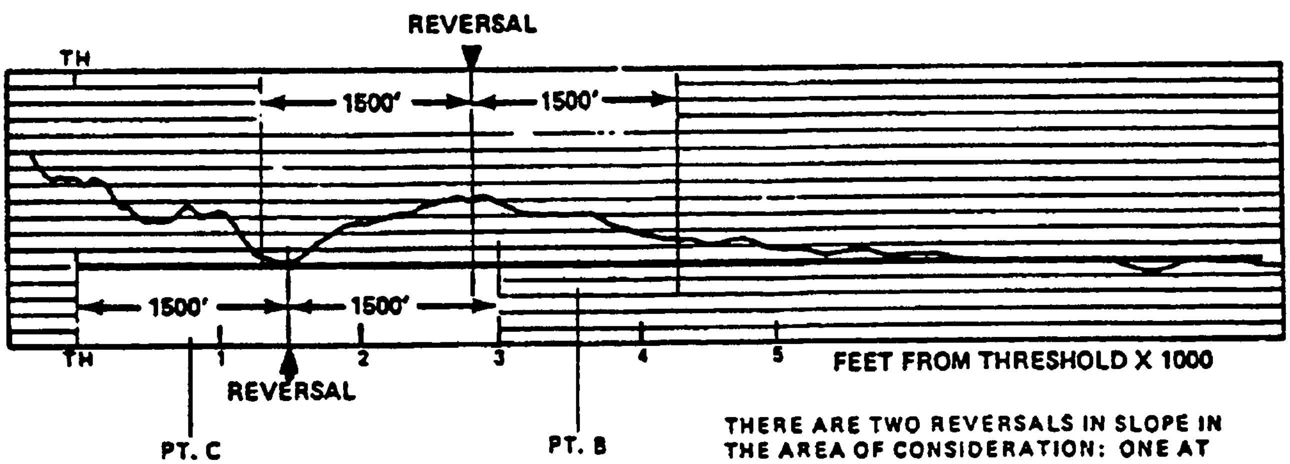


Figure 217-4

RATE OF CHANGE/REVERSAL IN THE SLOPE OF THE GLIDE PATH



THERE ARE TWO REVERSALS IN SLOPE IN THE AREA OF CONSIDERATION: ONE AT 2800 FEET AND ANOTHER AT 1500 FEET FROM THE THRESHOLD. EACH REVERSAL MEETS THE REQUIREMENT THAT THE SLOPE OR TREND ON AT LEAST ONE SIDE OF THE BREAK EXTENDS FOR AT LEAST 1500 FEET.

217.5 TOLERANCES.

CODES:

C — Tolerances that are applied to site, commissioning, reconfiguration, and categorization inspection.

P — Tolerances that are applied to any inspection subsequent to the inspections outlined in Code C.

a. Localizers.

PARAMETER	REFERENCE	INSPECTION C	INSPECTION P	TOLERANCE/LIMIT
Spectrum Analysis	Reserved			
Modulation Level	217.3202	X	X	40% ± 4%
Waveguide Clearance XMTR		X	X	40% ± 4% (Those facilities which support a back course.)
Power Ratio	217.3204	X	X	The power level output of the course transmitter shall be at least 10 dB greater than the clearance transmitter.
Phasing	217.3205	As Required		No tolerance.
Width—	217.3206			Maximum—6.0° (SDF-12.0°). CAT II & III tailored to 700 feet. Precision approach—400 feet minimum course width at the threshold.
Front Course		X		± 0.1° of the commissioned width.
			X	Within 17% of the commissioned width.
			X	CAT III: Within ± 10% of the commissioned width.
Transmitter Differential (Front Course)		X	X	Not greater than 0.5° or 10% of the commissioned width, whchever is least.
Back Course	217.3206	X		Between 3.0° and 6.0°.
			X	Between 2.49° and 7.02° in normal or monitor alarm condition.
		X	X	SDFs — Within 10% of the front course sector width.
		X	X	Exception: MRN-7 if used for any purpose: 10.0° ± 5.0°.
Symmetry (Front Course Only)	217.3206	X	X	With the facility in normal: 45-55%.
Alignment	217.3207			
Front Course and Independently Monitored Back Courses		X		Within ± 3 μA of the designed procedural azimuth.
			X	For ILS's, Localizer-only on centerline and SDFs on centerline. From the designed procedural azimuth: CAT I ± 15 μA. CAT II ± 11 μA. CAT III ± 9 μA. Offset Localizers, LDAs. Offset SDFs ± 20 μA. Back Course ± 20 μA.

217.5 TOLERANCES.

CODES:

C — Tolerances that are applied to site, commissioning, reconfiguration, and categorization inspection.

P — Tolerances that are applied to any inspection subsequent to the inspections outlined in Code C.

a. Localizers.

PARAMETER	REFERENCE	INSPECTION C	INSPECTION P	TOLERANCE/LIMIT
Spectrum Analysis	Reserved			
Modulation Level	217.3202	X	X	40% ± 4%
Waveguide Clearance XMTR		X	X	40% ± 4% (Those facilities which support a back course.)
Power Ratio	217.3204	X	X	The power level output of the course transmitter shall be at least 10 dB greater than the clearance transmitter.
Phasing	217.3205	As Required		No tolerance.
Width—	217.3206			Maximum—6.0° (SDF-12.0°). CAT II & III tailored to 700 feet. Precision approach—400 feet minimum course width at the threshold.
Front Course		X		± 0.1° of the commissioned width.
			X	Within 17% of the commissioned width.
			X	CAT III: Within ± 10% of the commissioned width.
Transmitter Differential (Front Course)		X	X	Not greater than 0.5° or 10% of the commissioned width, whchever is least.
Back Course	217.3206	X		Between 3.0° and 6.0°.
			X	Between 2.49° and 7.02° in normal or monitor alarm condition.
		X	X	SDFs — Within 10% of the front course sector width.
		X	X	Exception: MRN-7 if used for any purpose: 10.0° ± 5.0°.
Symmetry (Front Course Only)	217.3206	X	X	With the facility in normal: 45-55%.
Alignment	217.3207			
Front Course and Independently Monitored Back Courses		X		Within ± 3 µA of the designed procedural azimuth.
			X	For ILS's, Localizer-only on centerline and SDFs on centerline. From the designed procedural azimuth: CAT I ± 15 µA. CAT II ± 11 µA. CAT III ± 9 µA. Offset Localizers, LDAs. Offset SDFs ± 20 µA. Back Course ± 20 µA.

PARAMETER	REFERENCE	INSPECTION C	INSPECTION P	TOLERANCE/LIMIT
Monitors	217.3208			
Alignment Front Course				The course alignment monitor shall alarm when the actual course alignment signal shifts from the designed procedural azimuth by no greater than:
Facilities aligned along the runway.		X	X	CAT I ILS and SDFs aligned along runway centerline ± 15 μA CAT II ± 11 μA CAT III ± 9 μA.
Offset Localizers, Offset SDFs, and LDAs		X	X	± 20 μA from the designed procedural azimuth when using actual course alignment references, i.e., AFIS, theodolite, etc..
Localizers, SDF's, and LDA's where alignment is determined to be satisfactory by visual observations	217.3208a(1)(c)	X	X	±20uA from established equality of modulation reference.
Back Course		X	X	± 20 μA from the alignment achieved at commissioning.
Width Front Course & Independently Monitored Back Courses		X	X	Not more than ± 17% of the commissioned width.
RF Power	217.3209	X		Maintained at or above: Signal Strength—5 μV Flag Alarm Current—240 μA Clearance and Structure—in tolerance.
Coverage	217.3211	X	X	At or greater than: Signal Strength—5 μV Flag Alarm Current—240 μA Clearance and Structure — in tolerance Interference—shall not cause an out-of-tolerance condition.
Clearances (Front and Back Course) Facility in Normal configuration.	217.3210	X	X	As measured from the procedural designed azimuth: Sector — Minimum Clearance 1 — Linear increase to 175 μA then maintain 175 μA to 10°. 2 — 150 μA (see note). 3 — 150 μA (see note).
Facility in any alarm configuration.		X	X	Clearances are reduced 15 μA from the clearance required in normal.
	217.43	X	X	NOTE: Exceptions are authorized in Sectors 2 and 3.
Polarization	217.3213	X	X	Polarization error not greater than: CAT I ± 15 μA CAT II ± 8 μA CAT III ± 5 μA
Identification and Voice	217.3214	X	X	Clear, correct; audio level of the voice equal to the identification level. The identification shall have no effect on the course. Voice modulation shall not cause more than 5 μA of course disturbance.

b. Glide Slopes.

PARAMETER	REFERENCE	INSPECTION C	INSPECTION P	TOLERANCE/LIMIT
Spectrum Analysis	Reserved			
Modulation Level	217.3302	X		80% ± 2%
			X	80% ± 5%
Modulation Equality	217.3303	As Required		Zero μA ± 5μA
Phasing and Airborne Phase Verification	217.3304	As Required		No Tolerance
Engineering & Support Tests	217.3305 217.33051 217.33052 217.33053 217.3311	As Required		No Tolerance
Width	217.3306b	X		0.7° ± 0.05°
			X	0.7° ± 0.2° Site Survey, USAF test van: 0.7° ± 0.1°
Angle	217.3306a(2)	X		Within ± 0.05° of the commissioned angle.
	217.3306a(1)		X	Within + 10.0% to -7.5% of the commissioned angle.
			X	CAT III within ± 4.0% of commissioned angle. Site Survey, USAF test van: ± 0.1° of the commissioned angle.
Alignment	217.3310	X	X	CAT I — Not applicable CAT II and III: Zone 3 ± 37.5 μA about the commissioned angle at Point B; expanding linearly to ± 48.75 μA about the commissioned angle at Point C; expanding linearly to ± 75 μA about the commissioned angle at ILS reference datum.
Tilt	217.3309	X	X	Within + 10.0% to -7.5% of the commissioned angle.
Transmitter Differential	217.3306a	X		± 0.10°
			X	± 0.20°
Threshold Crossing Height		X		CAT II and III: 50 to 60 ft.
Symmetry	217.3306c	X	X	The following criteria is applied with the facility in a normal configuration: CAT I 67-33%. Broad sector either above or below path. CAT II 58-42%. Broad sector either above or below path. 67-33%. Broad sector below path only. Cat III 58-42%. Broad sector either above or below path.

PARAMETER	REFERENCE	INSPECTION C	INSPECTION P	TOLERANCE/LIMIT
Structure below Path	217.3306d	X	X	190µA or greater of fly-up signal occurs at an angle which is at least 30% of the commissioned angle.
		X	X	Exception: If this tolerance cannot be met, apply clearance procedures and tolerances.
Clearance Below the Path	217.3307	X	X	Adequate obstacle clearance at 180 µA or greater of fly-up signal in normal (150 µA or greater in any monitor limit condition).
Above the Path		X	X	150 µA of fly-down signal occurs at some point prior to the first false path.
Structure	217.3310 217.41 217.42			
With AFIS or Tracking Device.		X	X	
Zone 1 2 3				Category 1 30 µA from graphical average path. 30 µA from actual path angle. 30 µA from graphical average path
Zone 1 2 3				Category II and III 30 µA from graphical average path. From actual path angle 30 µA at Point A, then a linear decrease to 20 µA at Point B. 20 µA from the graphical average path.
Without AFIS or tracking device.	217.23		X	
Zone 1 2 3				Category 1 30 µA from the graphical average path. 30 µA from the graphical average path. 30 µA from the graphical average path.
	217.41		X	Exception: An aggregate out-of-tolerance condition for 354 feet may be acceptable in a 7,089-foot segment.
Change/Reversal	217.42	X	X	25 µA per 1,000 feet in a 1,500-foot segment.
Coverage	217.3312	X	X	At or greater than: Signal Level: 15 µV Flag Alarm Current: 240 µA Fly-up Signal: 150 µA Clearance and Structure in tolerance. Interference shall not cause an out-of-tolerance condition.

PARAMETER	REFERENCE	INSPECTION C	INSPECTION P	TOLERANCE/LIMIT
Monitor Reference Values	217.3313			
Angle		X	X	Within + 10.0% to -7.5% of the commissioned angle (applicable to SBR, Wave Guide, and EFGS)
Width		X	X	0.9° maximum. 0.5° minimum.
RF Power	217.3314	X	X	Not less than: Signal Level—15 µV.

217.6 Adjustments. See paragraph 106.45. When equipment performance characteristics are abnormal but within tolerances, they should be discussed with maintenance personnel to determine if adjustments will increase the overall performance of the systems. There is no need to optimize a facility during routine periodic checks. Following any adjustment to correct an out-of-tolerance condition, the appropriate monitor shall be checked and proper monitor operation verified.

SECTION 218. APPROACH LIGHTS

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SECTION 218. APPROACH LIGHTS

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SECTION 218. APPROACH LIGHTS

218.1 Introduction

a. **An approach lighting system** is a configuration of signal lights disposed symmetrically about the runway centerline extended, starting at the runway threshold and extending outward into the approach zone. This system provides visual information on runway alignment, height perception, roll guidance and horizontal references.

b. **Approach lighting systems are designed** to improve operational capability and safety of aircraft during approach and landing operations, particularly during the hours of darkness and/or reduced visibility. Although these facilities are considered visual navigational facilities, they are used with electronic landing aids, and generally will support reduced visibility minimums.

c. **In order to meet the objective of improved safety**, the approach lighting system configurations and equipment must be consistent and suited to operational requirements.

218.101 Category I Approach Lighting System, Sequenced Flashers, (ALSF-1), (Figure 218-3). This is a Category I approach lighting system with sequenced flasher lights. It consists of a light bar containing five lamps at each 100-foot interval starting 300 feet from the runway threshold and continuing out to 3000 feet (total of 28 centerline bars). Light bars are installed perpendicular to the runway centerline extended and all lights are aimed away from the runway threshold. The centerline light bar at 1000 feet from the threshold is supplemented with eight additional lights on either side forming a light bar 100 feet long and containing 21 lights. This bar is called the 1000-foot bar. All of the aforementioned lights are white in color. The terminating bar, installed 200 feet from the threshold, is 50 feet long and contains 11 red lights. Wing bars or pre-threshold bars, each containing 5 red lights, are located 100 feet from the threshold, one on either side of the runway. The innermost light (nearest runway centerline) of each wing is located in-line with the runway edge lights. The threshold bar is a row of green lights spaced 5 to 10 feet apart which are located near the threshold and extended across the runway threshold to approximately 45 feet from the runway edge on either side of the runway. The ALSF-1 operates on five intensity settings of 100%; 20%; 4%; 0.8%; and 0.16%. This system may be authorized for approval of Category II minima by appropriate authority.

218.102 Category II Approach Lighting System, Sequenced Flashers, (ALSF-2), (Figure 218-3). The ALSF-2 is the standard Category II approach lighting system and differs from the ALSF-1 system only in the inner 1000 feet (nearest the runway threshold) with the outer 2000 feet being identical for both. The terminating bar and wing bars of the ALSF-1 configuration are replaced with centerline bars of 5 white lights each. In addition, there are side row bars containing 3 red lights each on either side of the centerline bars at each light station in the inner 1000 feet. Also, this system has an additional light bar (4 white lights each) on either side of the centerline bar 500 feet from the threshold. These lights form a crossbar referred to as the 500-foot bar. The ALSF-2 operates on five intensity settings of 100%; 20%; 4%; 0.8%; and 0.16%.

218.103 Sequenced Flashers for ALSF-1 and ALSF-2. In addition to the steady burning lights, both configurations are augmented with a system of sequenced flashing lights. One such light is installed at each centerline bar starting 1000 feet from the threshold, out to the end of the system 3000 feet from the threshold. Sequenced flasher lights on U.S. Air Force installations will commence 200 feet from the runway threshold. These lights sequence toward the threshold at a rate of twice per second. They appear as a ball of light traveling in the direction of the landing runway threshold at a very rapid speed.

218.104 Simplified Short Approach Lighting System (SSALS), (Figure 218-3). This is a 1400-foot system and utilizes the standard ALS centerline light bar hardware and is capable of being upgraded to a standard 3000-foot system. It consists of seven light bars of five white lamps each, spaced 200 feet apart, beginning 200 feet from the threshold. Two additional light bars, containing five white lamps each, are located on either side of the centerline bar at 1000 feet from the runway threshold forming a crossbar 70 feet long. All lights in this system operate on three intensity settings of approximately 100%; 20%; and 4%.

218.105 Simplified Short Approach Lighting System with Sequenced Flashers (SSALF), (Figure 218-3). This system is identical to the SSALS system except for the addition of three sequenced flashers located on the runway centerline at the outer three light bar stations. These flashers assist pilots in making early identification of the system in areas of extensive ambient background light. The sequenced flashers have an "on-off" switch and will operate on all intensity settings of the steady burning lights.

218.106 Simplified Short Approach Light System with Runway Alignment Indicator Lights (SSALR), (Figure 218-3). This is a 3000-foot system and is identical to the SSALS except that eight sequenced flasher lights spaced 200 feet apart are added on the centerline, beginning 200 feet beyond the end of the SSALS system. The sequenced flashers have a separate on-off switch but do not have a separate intensity control; they operate with all intensity settings of the steady burning lights and runway edge lights.

218.107 Medium Intensity Approach Lighting System (MALS), (Figure 218-3). This system is 1400 feet in length, consisting of seven light bars of five lamps each, located on the runway centerline, extended and spaced 200 feet apart. Two additional light bars are located on either side of the centerline bar at 1000 feet from the runway threshold. All lights in this system operate on two intensity settings, 100% and 10%, controlled through the runway edge lighting system.

218.108 Medium Intensity Approach Lighting System with Sequenced Flashers (MALSF), (Figure 218-3). This system is identical to the MALS except that three sequenced flasher lights are located at the outer three light bar stations. These sequenced flashers do not have an intensity control; they operate on both intensity settings of the steady burning lights.

218.109 Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR), (Figure 218-3). This system is the same as a MALS configuration except that eight sequenced flashers are added on the extended runway centerline, beginning 200 feet beyond the outer end of the MALS system and extending out at 200-foot intervals to 3000 feet. The MALSR and SSALR may have an overall length of 2400 feet at locations where the glide slope is greater than 2.75 degrees. The MALSR may be used with precision navigation aids, i.e., PAR, ILS.

218.110 U.S. Army Standard Approach Lighting System (Figure 218-3). A high intensity system, 1500 feet in length consisting of a green threshold light bar, two red pre-threshold light bars, three red terminating light bars, two white light bars at 1000 feet from the runway threshold and single white light bars at 100 feet to a distance of 1500 feet. Sequenced flasher lights on the centerline bars are optional.

218.111 Omnidirectional Approach Lighting System (ODALS) consists of seven omnidirectional flashing lights. Five lights are located on the runway centerline extended, with the first light located 300 feet from the threshold and extending at equal intervals up to 1,500 feet from the threshold. The other two lights are located, one on each side of the runway threshold. They shall flash in sequence toward the runway threshold at a rate of once per second, with the two lights located on each side of the runway flashing simultaneously.

218.112 Runway End Identifier Lights (REIL), (Figure 218-3). The function of the REIL is to provide rapid and positive identification of the approach end of the runway. The REIL does not provide course alignment, descent or altitude information. The system consists of two synchronized flashing lights, one on each side of the landing threshold, facing the approach area. The lights flash at a rate of twice per second.

218.2 Pre-Flight Requirements

218.21 Facilities Maintenance. In addition to preparations contained in Section 106.21, facilities maintenance personnel should ensure that all light units are operating, aimed at the proper angle, and in a clean condition.

218.22 Air. The flight inspector should consult with appropriate personnel to determine local operational procedures and the correct transmitter keying sequence for Radio Controlled Lights. Also see Section 106.22.

218.3 Flight Inspection Procedures

a. These lighting system configurations are identified as the United States Standard. While there are other approach lighting system configurations in existence, no attempt has been made to describe all systems in this section due to the fact that they are considered as non-standard lighting systems and will not be found in quantity. Where it is necessary to make an in-flight evaluation of non-standard systems, the flight inspector must determine that they fulfill the operational requirements for which they are installed and do not create signals which might be misleading or hazardous.

b. For airports with no prior IFR service or where night minimums are being revised, a night flight inspection shall be conducted to determine the adequacy of the light systems to support the procedure.

c. Approach lights, except semi-flush lights, are aimed vertically to a point on the ILS or PAR glide path 1600 feet in advance of the light; therefore, it is necessary that the aircraft be positioned on the glide path for proper evaluation. For non-precision type navigational facilities, a three-degree glide path angle is simulated for aiming purposes.

218.31 Checklist. The following checks will be performed on flight inspections of approach lighting systems and runway end identifier lights.

a. **Light Intensity**
b. **Lamp Alignment**
c. **Inoperative Lights**
d. **Radio Controlled Lights.**

218.32 Detailed Procedures. A commissioning flight inspection is required for all airport lighting systems, including approach lights, REILS, runway lights, and radio control of lights, that support a public-use or military instrument approach procedure. Recurring inspections will be conducted concurrently with the periodic inspection of the primary navigational facility which the lighting system supports. The periodic inspection of the primary navigational facility will be considered complete if circumstances prohibit inspection of the lighting system, provided all other checklist items have been accomplished satisfactorily.

218.321 Approach Light Systems

(1) Light Intensity. The flight inspector will have the approach lighting system sequenced through the normal intensity settings to determine that the relative brightness of each intensity setting is uniform. All light units should be operating with the proper filters in place depending on the type system installed.

(2) Lamp Alignment. The electronic glide slope angle will determine the proper aiming points for an Approach Lighting System. It is necessary to position the aircraft on the prescribed glide path to determine if each light and light bar is properly aimed in the system. For non-precision type instrument approaches, the lights and light bars are aimed along a theoretical glide slope angle of three degrees (3.0%). The flight inspector will identify the lights or light bars that are inoperative or misaligned; improper aiming, up or down, can be detected by positioning the aircraft above and below the normal approach path.

(3) Radio Controlled Lighting Systems. All radio controlled lighting systems associated with either a precision or non-precision Instrument Approach Procedure will be flight checked for satisfactory operation on commissioning and during subsequent periodic inspections. These light systems are activated and controlled by radio signals generated from an aircraft or a ground facility.

218.3 Flight Inspection Procedures

a. These lighting system configurations are identified as the United States Standard. While there are other approach lighting system configurations in existence, no attempt has been made to describe all systems in this section due to the fact that they are considered as non-standard lighting systems and will not be found in quantity. Where it is necessary to make an in-flight evaluation of non-standard systems, the flight inspector must determine that they fulfill the operational requirements for which they are installed and do not create signals which might be misleading or hazardous.

b. For airports with no prior IFR service or where night minimums are being revised, a night flight inspection shall be conducted to determine the adequacy of the light systems to support the procedure.

c. Approach lights, except semi-flush lights, are aimed vertically to a point on the ILS or PAR glide path 1600 feet in advance of the light; therefore, it is necessary that the aircraft be positioned on the glide path for proper evaluation. For non-precision type navigational facilities, a three-degree glide path angle is simulated for aiming purposes.

218.31 Checklist. The following checks will be performed on flight inspections of approach lighting systems and runway end identifier lights.

- **a. Light Intensity**
- **b. Lamp Alignment**
- **c. Inoperative Lights**
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(1) Light Intensity. The flight inspector will have the approach lighting system sequenced through the normal intensity settings to determine that the relative brightness of each intensity setting is uniform. All light units should be operating with the proper filters in place depending on the type system installed.

(2) Lamp Alignment. The electronic glide slope angle will determine the proper aiming points for an Approach Lighting System. It is necessary to position the aircraft on the prescribed glide path to determine if each light and light bar is properly aimed in the system. For non-precision type instrument approaches, the lights and light bars are aimed along a theoretical glide slope angle of three degrees (3.0%). The flight inspector will identify the lights or light bars that are inoperative or misaligned; improper aiming, up or down, can be detected by positioning the aircraft above and below the normal approach path.

(3) Radio Controlled Lighting Systems. All radio controlled lighting systems associated with either a precision or non-precision Instrument Approach Procedure will be flight checked for satisfactory operation on commissioning and during subsequent periodic inspections. These light systems are activated and controlled by radio signals generated from an aircraft or a ground facility.

Minima. When any of these systems are installed, they will be inspected in the same manner as the approach lighting system, i.e., if discrepancies are observed by the flight inspector, they should be described and reported in as much detail as possible to the operating or maintenance authority for corrective action at the earliest opportunity. The Air Traffic Control facility chief or other designated authority assigned such responsibility shall make the final decision regarding use of the Approach Lights, Runway Edge Lights, Touchdown Zone and Centerline Lights and issue appropriate Notice to Airmen.

218.5 Tolerances

218.51 Approach Lighting Systems, Runway Edge Lights, Touchdown Zone, and Runway Centerline Lights will meet the following tolerances. It is not intended that these facilities be classified in accordance with Section 107.1 unless a hazard to safety exists.

a. Light Intensity. The system shall be capable of operating on all light intensity settings; the relative intensity of all lights shall be uniform on each individual setting.

b. Lamp Alignment. All lamps shall be aimed in both vertical and horizontal axes to provide the proper guidance along an electronic glide path of approximately 3.0^{o}.

c. Inoperative Lights. For a commissioning inspection, all lights of each system must be operative, and proper filters must be in place. During routine inspection if inoperative, obscured, or misaligned lights are detected, the number and location shall be noted in as much detail as practicable and this information reported to the operating or maintenance authority for corrective action.

d. Touchdown Zone and Centerline Lighting Systems. These systems are integral parts of the Category II ILS and will conform to specified criteria. When reduced minimums have been authorized on the basis of these systems being available and operative, compliance with the below criteria is required for the application of reduced minimums. Whenever the system fails to meet the following requirements, out-of-tolerance conditions exist and the system automatically reverts to application of Category I minima.

(1) No more than 10% of the lights of the Centerline Lighting System shall be inoperative.

(2) No more than 10% of the lights on either side of the Touchdown Zone Lighting System shall be inoperative.

(3) No more than four consecutive lights of the Centerline Lighting system shall be inoperative.

(4) More than one bar (three-light fixture) of the touchdown zone system may be inoperative; however, two adjacent bars on the same side of the system shall not be inoperative. A bar is considered inoperative when all of its lights are out.

218.52 Runway End Identifier Lights (REIL) will meet the following tolerances. It is not intended that the facility be classified in accordance with Section 107.1 unless a hazard to safety exists.

a. Light Intensity. The lights shall be oriented so that the light intensity is substantially uniform on the runway centerline extended. The character of appearance of the light shall be aviation white or xenon ARC. No color is permitted, and both lights must be operative and precisely synchronized with a flash rate of 120 flashes (plus or minus 20) per minute.

b. Lamp Alignment. The system shall be aligned or shielded so as to be unobjectionable to a pilot on final approach within 1500 feet of the runway threshold on an approach path of 2.5^{o} or higher. If the REIL lights produce an unacceptable glare within 1500 feet of the runway threshold, the flight inspector shall request that the aiming of the lamps be adjusted.

218.6 Adjustments. Maintenance personnel should make every effort to correct any discrepancies discovered on an approach lighting system or a REIL system during the conduct of the flight inspection of the primary navigational facility. Where a hazard to safety exists, correction of discrepancies will be made prior to further use of the system; otherwise, correction of minor deficiencies will be made as soon as possible (Ref: Paragraphs 218.4 and 106.35).

Minima. When any of these systems are installed, they will be inspected in the same manner as the approach lighting system, i.e., if discrepancies are observed by the flight inspector, they should be described and reported in as much detail as possible to the operating or maintenance authority for corrective action at the earliest opportunity. The Air Traffic Control facility chief or other designated authority assigned such responsibility shall make the final decision regarding use of the Approach Lights, Runway Edge Lights, Touchdown Zone and Centerline Lights and issue appropriate Notice to Airmen.

218.5 Tolerances

218.51 Approach Lighting Systems, Runway Edge Lights, Touchdown Zone, and Runway Centerline Lights will meet the following tolerances. It is not intended that these facilities be classified in accordance with Section 107.1 unless a hazard to safety exists.

a. Light Intensity. The system shall be capable of operating on all light intensity settings; the relative intensity of all lights shall be uniform on each individual setting.

b. Lamp Alignment. All lamps shall be aimed in both vertical and horizontal axes to provide the proper guidance along an electronic glide path of approximately 3.0°.

c. Inoperative Lights. For a commissioning inspection, all lights of each system must be operative, and proper filters must be in place. During routine inspection if inoperative, obscured, or misaligned lights are detected, the number and location shall be noted in as much detail as practicable and this information reported to the operating or maintenance authority for corrective action.

d. Touchdown Zone and Centerline Lighting Systems. These systems are integral parts of the Category II ILS and will conform to specified criteria. When reduced minimums have been authorized on the basis of these systems being available and operative, compliance with the below criteria is required for the application of reduced minimums. Whenever the system fails to meet the following requirements, out-of-tolerance conditions exist and the system automatically reverts to application of Category I minima.

(1) No more than 10% of the lights of the Centerline Lighting System shall be inoperative.

(2) No more than 10% of the lights on either side of the Touchdown Zone Lighting System shall be inoperative.

(3) No more than four consecutive lights of the Centerline Lighting system shall be inoperative.

(4) More than one bar (three-light fixture) of the touchdown zone system may be inoperative; however, two adjacent bars on the same side of the system shall not be inoperative. A bar is considered inoperative when all of its lights are out.

218.52 Runway End Identifier Lights (REIL) will meet the following tolerances. It is not intended that the facility be classified in accordance with Section 107.1 unless a hazard to safety exists.

a. Light Intensity. The lights shall be oriented so that the light intensity is substantially uniform on the runway centerline extended. The character of appearance of the light shall be aviation white or xenon ARC. No color is permitted, and both lights must be operative and precisely synchronized with a flash rate of 120 flashes (plus or minus 20) per minute.

b. Lamp Alignment. The system shall be aligned or shielded so as to be unobjectionable to a pilot on final approach within 1500 feet of the runway threshold on an approach path of 2.5° or higher. If the REIL lights produce an unacceptable glare within 1500 feet of the runway threshold, the flight inspector shall request that the aiming of the lamps be adjusted.

218.6 Adjustments. Maintenance personnel should make every effort to correct any discrepancies discovered on an approach lighting system or a REIL system during the conduct of the flight inspection of the primary navigational facility. Where a hazard to safety exists, correction of discrepancies will be made prior to further use of the system; otherwise, correction of minor deficiencies will be made as soon as possible (Ref: Paragraphs 218.4 and 106.35).

SECTION 219. 75 Mhz MARKER BEACON

CROSS INDEX

SECTION 219. 75 MHz MARKER BEACON

219.1 Introduction.

a. This section provides instructions and performance criteria for certifying 75 megahertz (MHz) marker beacons.

b. The marker beacon is a VHF radio transmitter which propagates an elliptically-shaped (fan) vertical radiation pattern on an assigned frequency of 75 MHz. The radiation pattern is composed of a major and a minor axis. The major axis is defined as the longest diameter of the elipse while the minor axis is the shortest diameter, See Figure 219-1.

c. Functionally, marker beacons provide an aural and visual indication of station passage in association with facilities providing course guidance. Identification is provided by both a modulation frequency and a keying code.

d. Although marker beacons are basically of the same type and function, their nomenclature is generally divided into two categories: ILS markers and fan markers. The operational requirements and category are dependent upon instrument flight procedural application.

219.11 ILS Markers Description. These markers are located on the approximate instrument runway centerline extended in accordance with installation criteria specified in other documents. They are installed to indicate the position of an aircraft along the instrument approach course.

a. Outer Marker (OM).

(1) Modulation Frequency. 400 Hz, Visual Signal--Illuminates the blue lamp.

(2) Keying Code. Continuous dashes at a rate of two per second.

b. Middle Marker (MM).

(1) Modulation Frequency. 1300 Hz, Visual Signal--Illuminates the amber lamp.

(2) Keying Code. Alternating dots and dashes at a rate of 95 combinations per minute.

c. Inner Marker (IM).

(1) Modulation Frequency. 3000 Hz, Visual Signal--Illuminates the white lamp.

(2) Keying Code. Continuous dots at a rate of six dots per second.

219.12 Fan Markers (FM) Description. These markers are generally associated with nonprecision approach procedures; however, they may be associated with an ILS to serve as a localizer stepdown fix or MAP for circling approaches to secondary airports.

a. Modulation Frequency. 3000 Hz, Visual Signal--Illuminates the white lamp.

b. Keying Code.

(1) Back Course Marker. Two dot pairs at a rate of 95 pairs per minute; older equipment, 72 pairs per minute.

(2) Other Installations. Morse code letter R (• — •). Where more than one approach marker is located in the same area, different identification keying is necessary to avoid confusion. The Morse code letters K (— • —), P (• — — •),X (— • • —), and Z (— — • •) will be used in the priority listed.

219.2 Preflight Requirements.
See paragraph 106.2

219.21 Facilities Maintenance Personnel. The following information shall be furnished to flight inspection prior to the commissioning check:

a. The proposed operational configuration of any adjacent marker beacon facilities which could produce interference, i.e., simultaneous operation proposed or interlock device installed.

b. Any facility alterations performed because of unique siting requirements, e.g., 8 KHz frequency separation between markers serving parallel approaches.

219.22 Flight Personnel. The calibration card shall be used to obtain the milliampere equivalent of 1,700 microvolts (*u*V) required for each modulation frequency (400 Hz, 1300 Hz, 3000 Hz); e.g., 1.8 milliampere (mA) may represent the 1700 *u*V level instead of 2.0 mA. Determine the number of light lines which represent the 1700 *u*V signal and use this reference as the minimum acceptable signal level when evaluating marker beacon coverage.

219.3 Flight Inspection Procedures.

219.31 Checklist. Markers are installed as a constituent part of some other primary aid; therefore, they are inspected concurrently with the primary aid.

ILS AND FAN MARKERS

Type Check	Ref. Para. 219.xxx	Inspections: Commissioning	Periodic	Antenna and/or transmission lines Replacement/Adjustment
Spectrum Analysis	Reserved	Reserved	Reserved	Reserved
Identification and Modulation Tone	.3202	X	X	X
Coverage	.3203			
Major axis		X	—	—
Minor axis		X	X	X
Proximity Check		X	—	—
Holding Fixes	.3205	X	—	X
Standby Equipment	.3206 106.32	X	—	—
Standby Power	.3207 106.43	X	—	—

219.22 Flight Personnel. The calibration card shall be used to obtain the milliampere equivalent of 1,700 microvolts (*u*V) required for each modulation frequency (400 Hz, 1300 Hz, 3000 Hz); e.g., 1.8 milliampere (mA) may represent the 1700 *u*V level instead of 2.0 mA. Determine the number of light lines which represent the 1700 *u*V signal and use this reference as the minimum acceptable signal level when evaluating marker beacon coverage.

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ILS AND FAN MARKERS

		Inspections		
Type Check	Ref. Para. 219.xxx	Commissioning	Periodic	Antenna and/or transmission lines Replacement/Adjustment
Spectrum Analysis	Reserved	Reserved	Reserved	Reserved
Identification and Modulation Tone	.3202	X	X	X
Coverage	.3203			
Major axis		X	—	—
Minor axis		X	X	X
Proximity Check		X	—	—
Holding Fixes	.3205	X	—	X
Standby Equipment	.3206 106.32	X	—	—
Standby Power	.3207 106.43	X	—	—

219.32 Detailed Procedures.

219.3201 Spectrum Analysis. Reserved.

219.3202 Identification and Modulation Tone. The purpose of this check is to ensure that the correct modulation tone and keying code are transmitted without interference throughout the area of required coverage Keying rate is checked by facility maintenance personnel.

Approved Procedure. Record and evaluate the keying code while flying in the radiation pattern at the proposed or published altitude(s). Check that the audio modulation tone is correct by noting that the proper light comes on for the type marker being inspected; e.g., the OM illuminates the blue lamp.

219.3203 Coverage. This check is conducted to assure that the facility will provide a radiation pattern that supports operational requirements without interfering with other facilities or instrument flight procedures. All of the commissioning coverage requirements shall be completed with any adjacent marker beacons removed from service to preclude a misrepresentative coverage analysis caused by signal intermixing. The aircraft marker beacon sensitivity shall be set at the low position for all checks.

a. Minor Axis. This check is performed to measure the actual width and quality of the radiation pattern along the procedural course where it will be used.

(1) Approved Procedure. Fly through the marker beacon signal while inbound on the electronic course providing approach guidance. Maintain the published minimum altitude to check marker beacons that support nonprecision approaches. For markers that support precision instrument flight procedures, the preferred method is to fly down the glidepath. An alternate procedure is to maintain the altitude at which the glide slope intersects the marker location. If the facility supports both precision and nonprecision procedures, and the difference between the respective intercept altitudes exceeds 100 feet, conduct the initial check at both altitudes, thereafter, either altitude may be used. **Note:** Coverage will be considered satisfactory when the width is between 1,350 and 4,000 feet; 2,000 feet is the optimum width.

b. Major Axis. This measurement is conducted to verify that the marker beacon provides adequate coverage by measuring the width of the minor axis at the extremities of a pre-defined off-course sector. There is no requirement to flight inspect major axis coverage for inner markers. It is not necessary to obtain the limits of actual coverage unless requested as an engineering assist.

(1) Approved Procedure. Fly through the marker beacon signal while positioned on the course or microamp displacement which defines the required coverage limits (see Figure 219-2). Maintain the altitudes required for the minor axis measurements.

(2) Coverage Limits. The required coverage limits are predicated upon the type facility providing course guidance:

(a) Unidirectional facilities; e.g., LOC/LDA/SDF. Coverage shall be provided 75*u*A each side of the localizer on-course signal, with the facility in normal.

(b) Omnidirectional facilities; e.g., VOR, NDB, etc. Coverage shall be provided 5° each side of the on-course signal.

c. Proximity Check. These inspections supplement the basic coverage checks to assure operational compatibility between a marker beacon sited in close proximity to another marker beacon(s). The check may be performed prior to the commissioning inspection as a type of site evaluation. It shall be performed on each applicable marker beacon prior to authorizing operational use.

(1) Marker Beacon Signal Intermix. This check is conducted to determine if there is unacceptable signal derogation caused by the simultaneous operation of two or more marker beacons in close proximity.

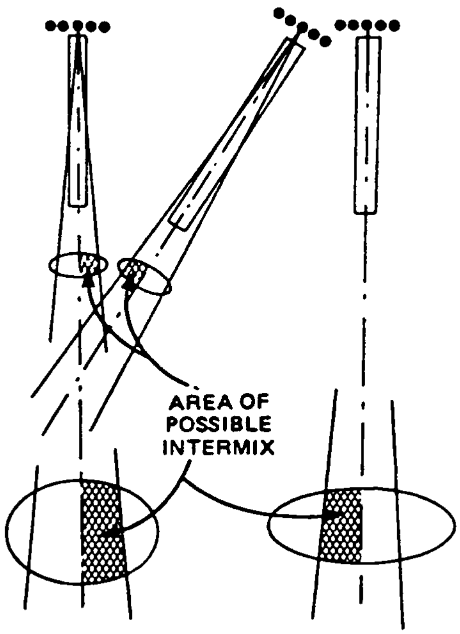
(a) Approved Procedure. Perform periodic checklist items with all marker beacons operating as proposed; in addition, check the major axis at the lowest procedural altitude on the side of the marker beacon closest to the adjacent marker. Assure that in-tolerance parameters and the following conditions are met:

1 No adverse audio interference; i.e., heterodyne.

2 Distinct fix indication that is not vague or distorted.

Figure 219-3

MARKER BEACON/PROCEDURE INTERMIX

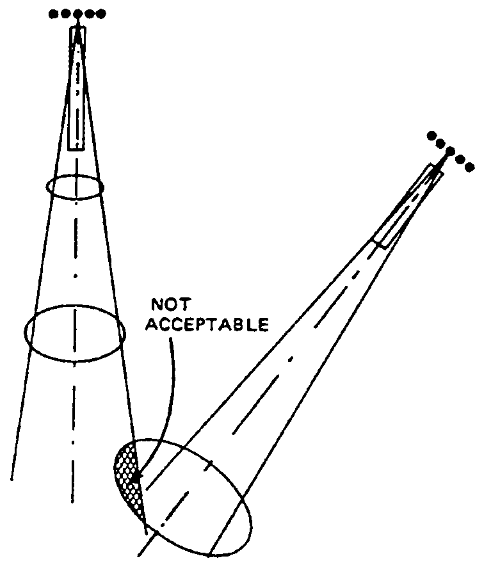


(2) Marker Beacon/Procedure Overlap. This check is conducted to assure that there are no false marker beacon indications present along an instrument approach course, which would authorize a premature descent prior to the point at which the actual fix position/marker beacon occurs. This situation could exist if the "intruding" marker beacon signal had the same modulation, even though the identifications may differ. Conduct this check only if it is suspected that this condition exists. See Figure 219-4.

(a) Approved Procedure. The flight inspector shall position the aircraft at the extremity of the approach course (150uA or 5^{O}, as appropriate) nearest the potentially misleading marker beacon at the minimum procedural altitude. If the signal intrusion into the approach area is at or above 1700uV, the procedure must be suspended until the signal intrusion can be reduced to less than 1700uV. If the signal cannot be reduced, the procedure shall be denied or the misleading marker removed from service.

Figure 219-4

MARKER BEACON OVERLAP



219.3204 Measurement Methods. Formulas appropriate to the following measurement methods are listed in Section 302.

a. Ground Speed. Using an approved unit that provides a ground speed readout, derive the average ground speed and note it on the recording. Ascertain the time required to traverse the pattern; then calculate the width using time and ground speed.

b. True Airspeed. Maintaining a constant true airspeed and altitude, traverse the marker beacon pattern on the appropriate course. A reciprocal flight shall be made in the opposite direction to eliminate the effects of wind. Calculate the width using the true airspeed and time for each crossing.

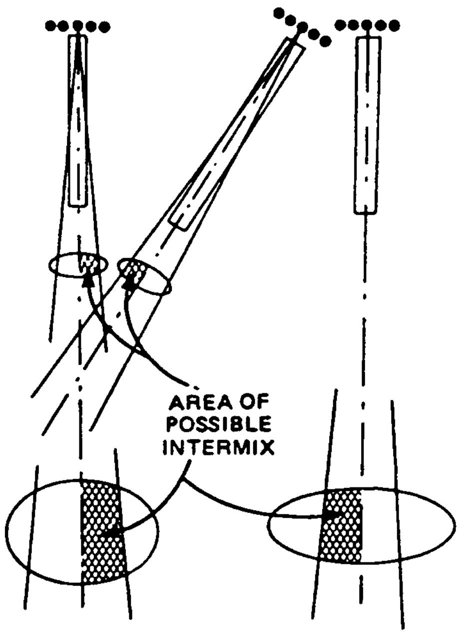
c. Known Distance. When the distance between two points on, or reasonably close to, the desired track are known (marker to runway, etc.), maintain a constant indicated airspeed and altitude throughout the segment and calculate the width by proportioning the marker distance to the known distance.

1 No adverse audio interference; i.e., heterodyne.

2 Distinct fix indication that is not vague or distorted.

Figure 219-3

MARKER BEACON/PROCEDURE INTERMIX



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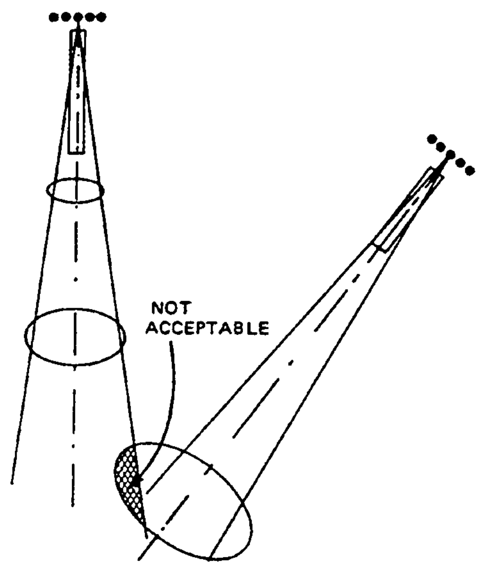
(a) Approved Procedure. The flight inspector shall position the aircraft at the extremity of the approach course (150uA or 5^{o}, as appropriate) nearest the potentially misleading marker beacon at the minimum procedural altitude. If the signal intrusion into the approach area is at or above 1700uV, the procedure must be suspended until the signal intrusion can be reduced to less than 1700uV. If the signal cannot be reduced, the procedure shall be denied or the misleading marker removed from service.

Figure 219-4

MARKER BEACON OVERLAP



219.3204 Measurement Methods. Formulas appropriate to the following measurement methods are listed in Section 302.

a. Ground Speed. Using an approved unit that provides a ground speed readout, derive the average ground speed and note it on the recording. Ascertain the time required to traverse the pattern; then calculate the width using time and ground speed.

b. True Airspeed. Maintaining a constant true airspeed and altitude, traverse the marker beacon pattern on the appropriate course. A reciprocal flight shall be made in the opposite direction to eliminate the effects of wind. Calculate the width using the true airspeed and time for each crossing.

c. Known Distance. When the distance between two points on, or reasonably close to, the desired track are known (marker to runway, etc.), maintain a constant indicated airspeed and altitude throughout the segment and calculate the width by proportioning the marker distance to the known distance.

219.5 Tolerances. Marker beacons shall meet these tolerances or be removed from service. The following tolerances are applied with the receiver sensitivity in low:

Parameter	Reference Para 219.xxxx	Tolerance/Limit
Electromagnetic Spectrum	Reserved	Interference shall not cause an out-of-tolerance condition.
Identification	.3202	Distinct; correct; constant throughout the coverage area; and clearly distinguishable from any other markers.
Modulation	.3202	The modulation shall illuminate the following lights: OM - Blue Light (400 Hz) MM - Amber Light (1300 Hz) IM - White Light (3000 Hz) FM - White Light (3000 Hz)
Coverage	.3203	With a constant signal at or above 1700 microvolts (*u*V), the following widths shall be provided:
Minor Axis		
ILS Outer Marker	.3203a(1)NOTE 219.4	Width shall not be less than 1,350' or more than 4,000'
ILS Middle Marker		Width shall not be less than 675' or more than 1,325'
ILS Inner Marker		Width shall not be less than 340' or more than 660'
Fan Markers Used for a missed approach or step-down fix in the final approach segment.	219.4	Width shall not be less than 1,000' or more than 3,000'
All others		Same as ILS Outer Marker
Major Axis		
ILS Outer Marker	.3203b(2)(a)	Minimum: 700 Feet Maximum: 4,000 Feet Those markers installed to serve dual runways shall not exceed 4,000 feet within the normal localizer width sector of 150 *u*A either side of the procedural centerline.
ILS Middle Marker	.3203b(2)(a)	Minimum: 350 Feet Maximum: 1,325 Feet
ILS Inner Marker		Not Applicable
All Others	.3203b(2)(b)	Any duration not to exceed the respective minor axis tolerance.
Separation		A separation between the 1700*u*V points of succeeding marker patterns which provide a fix on the same approach course; e.g., MM to IM, shall be at least 709 feet.

SECTION 220. MICROWAVE LANDING SYSTEMS (MLS)

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SECTION 220. MICROWAVE LANDING SYSTEMS (MLS)

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SECTION 220. MICROWAVE LANDING SYSTEMS (MLS)

220.1 INTRODUCTION. This section details the flight inspection procedures and tolerances to be applied to microwave landing systems (MLS).

220.2 PREFLIGHT REQUIREMENTS.

a. Review of all facility data and computation of facility error budget.

b. Review of facility horizontal and vertical terrain and obstruction profiles to determine line-of-sight characteristics and areas of possible signal anomalies. These profiles will be provided by installation engineering personnel.

220.3 FLIGHT INSPECTION PROCEDURES.

220.31 Checklist.

TYPE OF CHECK	REF PARA 220.xxx	C	P	PM
Azimuth/Elevation ARC 20 NM	.3201	1		
Azimuth/Elevation ARC 10 NM	.3202	1	X	X
Vertical Coverage Elevation/Azimuth	.3203	X	2	2
Azimuth Approach	.3204	1	X	X
Elevation Approach	.3204	1	X	X
Azimuth Monitor References	.3205b(1)	X		2
Elevation Monitor References	.3205b(2)	X		2
Low Angle Elevation Clearance	.3205c	X		2
OCI Orbit	.3206	X	2	
Identification	.3207	X	X	X
DME	.53c	X	X	X

NOTES:

1. Minimum RF Power
2. Engineering or maintenance request

220.32 Detailed Procedures.

220.3201 Standard Service Volume (SSV) or Expanded Service Volume (ESV) Arc.

a. Purpose: A commissioning inspection maneuver to define and certify the operational range, lateral and vertical limits of the MLS service volume. Perform the inspection with the facility operating at the lowest computed power required to establish adequate signal coverage.

b. Positioning. The lateral limits of the SSV encompasses an arc of ± 40 degrees of proportional guidance about the azimuth antenna phase center at a distance of 20 NM from the approach reference datum (ARD). Using the elevation of the ARD as the reference, the vertical limits extend from 0.9 degree above the horizon to 20,000 feet AGL at 20 NM. Facilities that provide service beyond 20 NM and/or beyond ± 40 degrees shall be considered as an ESV. Start the arc at the maximum usable distance and 5 degrees outside proportional guidance limit. Maintain an altitude equal to the minimum glide path (MGP). If signal coverage of all MLS components cannot be maintained at the MGP, the MLS shall be restricted. There is no requirement to certify the lower, 0.9 degree, or higher, 20,000 feet, limits of vertical coverage unless procedurally or operationally required. DOD MMLS facilities are designed for 15 NM Service Volume. In addition, the RF power of the MMLS is monitored but not adjustable. A 20 NM arc flown at the normal RF power will simulate the power alarm condition. All DOD MMLS facilities shall be restricted beyond 15 NM.

c. Inspection.

(1) Evaluate the proportional guidance service volume in 10 degree increments. There shall be no less than 10 degrees proportional guidance either side of the procedural on course.

(2) While traversing the azimuth proportional guidance sectors, record azimuth and elevation deviation. Deviation crosspointer fluctuations greater than 0.5 degree that exceed 2 degrees of arc shall be validated by radial flight using the procedures outlined in paragraph 220.3203 (Vertical Coverage).

220.3202 Low Altitude Arc.

a. Purpose. A commissioning and periodic arc throughout the proportional guidance area to assure azimuth and elevation signal coverage at the lower edge of elevation deflection sensitivity.

b. Positioning. At a distance of between 5 and 10 NM from the ARD, start the arc 5 degrees outside the edge of the proportional guidance service volume. Vertical altitude shall be computed to equal the MGP x 0.75. The distance and altitude at which the arc is flown on commissioning will be recorded in AMIS. This shall be the reference for periodic evaluations.

c. Inspection.

(1) Evaluate the proportional guidance volume in 10-degree increments. There shall be no less than 10 degrees proportional guidance either side of the procedural on course.

(2) While traversing the proportional guidance sectors, record azimuth and elevation deviation. Deviation crosspointer fluctuations greater than 0.5 degree that exceed 2 degrees of arc shall be validated by radial flight using the procedures outlined in paragraph 220.3203 (Vertical Coverage).

220.3203 Vertical Coverage.

a. Purpose.

(1) A commissioning maneuver to evaluate vertical coverage of the azimuth and elevation on the procedural azimuth and at $\pm$ 10 degrees each side.

(2) Validate elevation and azimuth deviation crosspointer fluctuations noted on arcs.

b. Positioning. This check will be accomplished by a level run starting at 20 NM or ESV limits, whichever is farthest from the ARD. Start altitude shall be computed to equal the MGP x 0.75. Altitudes up to the MGP are acceptable outside the FAF if required to maintain signal integrity. Inside the FAF, the altitude shall be no higher than that equal to the MGP x 0.75.

c. Inspection. Record azimuth deviation, PFE, PFN, and CMN crosspointers. Observe the azimuth crosspointer for excessive signal aberrations which may indicate multipath or signal shadowing. Observe the elevation crosspointer for a smooth linear transition terminating between 15 and 20 degrees.

(1) When fluctuations exceed $\pm$ 0.5 degree within $\pm$ 10 degrees of the procedural on course, fly the approach offset 5 degrees each side of the procedural on course and apply PFN and CMN tolerances.

(2) Validation of deviations noted on arcs shall be discussed with maintenance personnel for corrective action. If not correctable, the area in question shall be restricted.

220.3204 MLS Approaches.

a. Purpose. This maneuver is performed to verify that the azimuth and elevation facilities will satisfactorily support the proposed or published approach and categories of intended use. The approach should be the first maneuver flown during a commissioning, reconfiguration, or restoration flight inspection, so that the azimuth and elevation course may be optimized to the desired procedural alignment.

b. Positioning. Approaches shall be evaluated on the designed procedural azimuth and the minimum glidepath unless otherwise indicated. For the purpose of evaluating structure, optimizing azimuth and elevation alignments, and conducting periodic inspections, start the approach at a distance not closer than the published FAF point or 6 miles from runway threshold, whichever is greater. For commissioning, fly an approach from the desired service volume limits on the MGP while the facility is at minimum RF power.

c. Inspection.

(1) Azimuth facilities sited along runway centerline to support Cat II/III Autoland shall be evaluated to the ARD. All other facilities shall be evaluated to the MAP. Approved RTT and/or AFIS methods shall be used for the approach evaluation. RTT Analysis shall utilize the techniques from paragraphs 217.3207 and 217.3306. The facility error budget will provide all tolerances to be used during commissioning and periodic flight inspection. Mean course error (MCE) shall be established prior to application of PFE tolerances. Evaluate DME distance accuracy. Exclude data in areas that are restricted due to facility performance.

(2) Visual Autoland or Category II or III Operations Authorized. On commissioning inspections, fly the aircraft directly over the runway centerline at threshold, touch down prior to point "D", and remain over centerline to point "E". This allows the recorder "0" reference line to be used as the position reference for structure evaluation. Complete the runway evaluation by

taxiing the aircraft on centerline from threshold to point "E". An additional MLS-3 approach accomplished with normal updates will then provide a comparative to allow periodic airborne evaluation of the rollout guidance.

220.3205 Monitor References.

a. Purpose. To provide facility maintenance personnel reference readings to be used in the validation of facility monitoring parameters. Facility discrepancies shall be assigned if the shift exceeds the PFE allowance at the ARD and/or MAP reference point, as applicable.

b. Inspection.

(1) Azimuth monitor references shall be established after the facility is optimized to a MCE within $\pm$ 0.02 degree of the procedural on course azimuth. After the MCE is established, have maintenance personnel shift the system to one side, record the reference, shift the same amount to the other side, record the reference, then restore to normal. Azimuth monitors can also be established on the ground when parked within proportional guidance and no closer than 1,000 feet to the facility.

(2) Elevation monitor references are established airborne and require the MGP to be established within $\pm$ 0.02 degree of the desired angle prior to accomplishment. Request an elevation angle change of no greater than 0.10 degree high, record the reference, have the elevation angle changed to no greater than 0.10 degree low, record the reference, then restore to normal.

c. Elevation Clearance Evaluation. Perform this check during a commissioning flight inspection when in low angle alarm. Three runs are required, one on centerline, and at 2 degrees either side of centerline. Fly at an angle equal to $[(MGP^0 \times 0.75) - 0.25^0]$. Ensure that adequate course guidance and obstacle clearance can be maintained from the FAF to the MAP.

220.3206 Out-of-Coverage Indication (OCI). The purpose of the OCI check is to ensure that no false angle decoding occurs outside of proportional guidance coverage areas. Fly an orbit radius of 6 to 10 miles about the azimuth facility for this check. The aircraft will be flown at an altitude as close to the MGP that line of site with the MLS facilities will allow. During the orbit, note the position of any decoded angles lasting longer than 4 seconds or 1.5 degrees of arc, whichever is greater. Return to the area after completing the orbit and manually program the decoded angle into the receiver. If the angle can be locked onto and flown as a radial, OCI is present and shall be corrected or the facility restricted.

220.3207 Identification. The purpose of the identification check is to ensure correct identification is received throughout the coverage area. The identification can be validated by listening to the Morse code or recording basic data word 6.

220.4 ANALYSIS.

a. Azimuth PFE, PFN, and CMN will be evaluated over any 40-second interval of radial flight within the coverage area. Measured parameters shall be in tolerance for no less than 95 percent of the interval measured. PFE tolerances shall only be applied with use of AFIS or RTT.

b. Elevation PFE, PFN, and CMN will be evaluated over any 10-second interval of radial flight within the coverage area when on a selected glide path at or above the MGP. Measured parameters shall be in tolerance for no less than 95 percent of the interval measured. PFE tolerances shall only be applied with use of AFIS or RTT when flown radially.

c. Manual analysis of PFN can be determined by measuring the signal deviations from the mean azimuth or elevation angle that have a duration greater than:

(1) 6.3 seconds for azimuth

(2) 2 seconds for elevation

d. Manual analysis of CMN can be determined by measuring the signal deviations from the mean azimuth or elevation angle that have a duration less than:

(1) 10.4 seconds for azimuth

(2) 6.3 seconds for elevation

(3) CMN filter bandpass frequency overlaps a portion of the PFE bandpass frequency. The resultant CMN signal will be superimposed upon the PFE component, resulting in a larger error than is actually present. CMN shall be reported after subtraction of the PFE component.

220.5 TOLERANCES.

220.51 Facility Error Budgets. Due to the unique siting requirements of each MLS installation and the resulting difference in tolerances, a MLS error budget shall be computed for each facility, utilizing the approved error budget program provided by Flight Inspection Policy and Standards. MLS azimuth siting shall determine the MLS Reference Point to be used in the computation of the error budget.

a. ARD when the azimuth is sited along runway centerline. (See Figure 220-3).

b. MAP when the azimuth is:

(1) Offset. (See Figure 220-4).

(2) Co-located azimuth with elevation. (See Figure 220-5).

(3) Heliports which are considered to be those facilities with less than 2,300 feet between the azimuth and the approach reference datum when sited along runway centerline.

(4) Non-precision approach aid terminating at point in space and not aligned with a precision runway. (See Figure 220-6.)

220.52 Azimuth.

a. Purpose. During commissioning and categorization flight checks, the MCE shall be aligned to within ± 0.02 degree of the procedural on course. On commissioning, or categorization flight checks, PFE tolerances will not be applied until the MCE for both the azimuth and elevation has been optimized.

b. Alignment shall be reported as the average flight inspection angle. Facilities found with an alignment that exceeds 60% of the allowable PFE shall generate a maintenance alert IAW Para 217.45b. Facilities shall not be NOTAMed unless the PFE allowance at the reference point is exceeded.

c. Azimuth sited along runway centerline.

(1) PFE = 20 feet not to exceed 0.25 degree referenced to the ARD

(2) PFN = 11.5 feet not to exceed 0.25 degree referenced to the ARD

(3) The CMN limit shall not exceed ± 0.10 degree in any coverage region within ± 10 degrees of runway centerline extended nor exceed ± 0.20 degree in any other region within coverage.

d. Offset azimuth, co-located azimuth with elevation, and heliports:

(1) PFE = 28 feet not to exceed 0.50 degree as referenced to the MAP

(2) PFN = 14 feet not to exceed 0.50 degree as referenced to the MAP

(3) CMN not to exceed 0.20 degree

e. Facilities Not Aligned as a Precision Approach Aid to a Runway.

(1) PFE = No requirement

(2) PFN = 0.50 degree

(3) CMN not to exceed 0.20 degree

(4) Alignment shall be considered satisfactory when the flight inspector determines that the azimuth on course and elevation rate of descent allow safe completion of the procedure as published.

220.53 Elevation.

a. Purpose. During commissioning and categorization flight checks, the MCE shall be aligned to within ± 0.02 degree of the procedural on course. On commissioning, or categorization flight checks, PFE tolerances will not be applied until the MCE for both the azimuth and elevation has been optimized.

b. Alignment shall be reported as the average flight inspection angle. Facilities found with an alignment that exceeds 60% of the allowable PFE shall generate a maintenance alert IAW Para 217.45b. Facilities shall not be NOTAMed unless the PFE allowance at the reference point is exceeded.

(1) PFE = 0.133 degree at the MLS reference point for a standard 3.0 degree angle. For angles above 3.00 degrees by a factor of (0.133 + 0.022 per degree).

(2) PFN = 0.087 degree at the MLS reference point for a standard 3.0 degree angle. For angles above 3.00 degrees by a factor of (0.087 + .0145 per degree)

(3) The CMN limit shall not exceed ± 0.10 degree in any coverage region within ± 10 degrees of runway centerline extended nor exceed ± 0.20 degree in any other region within coverage.

c. DME. The DME shall be evaluated as a DME/N throughout all areas of coverage.

d. Degradation Factors.

(1) Azimuth sited along runway centerline:

(a) With distance: The PFE and PFN limits, expressed in angular terms along the runway centerline, are 1.2 times the value at the ARD to a maximum of 0.25 degree at 20 NM from the ARD.

(b) With azimuth angle: The PFE and PFN limits expressed in angular terms at ± 40 degrees azimuth angle are 1.5 times the value on the extended runway centerline at the same distance from the ARD, to a maximum of 0.25 degree.

(c) With elevation angle below 9.0 degrees, no degradation allowed. From + 9 degrees to + 15 degrees, by a factor of 1.5 for the PFE and PFN limits to a maximum of 0.5 degree.

(2) Offset azimuth, co-located azimuth with elevation, and heliports:

(a) With distance: The PFE and PFN limits, expressed in angular terms along the procedural azimuth, are 1.2 times the value at the MAP to a maximum of 0.50 degree at 20 NM from the ARD.

(b) With azimuth angle: The PFE and PFN limits expressed in angular terms at ± 40 degrees azimuth angle, are 1.5 times the value on the extended runway centerline at the same distance from the MAP to a maximum of 0.5 degree.

(c) With elevation angle from + 9 degrees to + 15 degrees, by a factor of 1.5 for the PFE and PFN limits.

(3) Elevation:

(a) With distance: The PFE and PFN limit, expressed in angular terms along the runway centerline, are 1.2 times the value at the ARD.

(b) With azimuth angle: The PFE and PFN limits expressed in angular terms at ± 40 degrees azimuth angle are 1.5 times the value on the extended runway centerline at the same distance from the ARD.

(c) With increasing elevation angles: The PFE and PFN limits are degraded linearly from + 3 degrees to + 15 degrees, by a factor of 2.0 times the value at the ARD.

(d) With decreasing elevation angle: The PFE and PFN limits from + 3 degrees (or 60 percent of the MGP, whichever is less) to the coverage extreme are degraded linearly by a factor of 3 times the value at the ARD.

e. Basic Data Words (BDW) are associated with the operation of the landing guidance system. Essential basic data words are 1, 2, 3, 4, and 6.

f. Auxiliary Data Words (Aux Data) provides information used for RNAV approaches. Essential aux data words are 1, 2, and 3. Facilities sited to support Category II/III autoland or RNAV curved approach procedures shall radiate correct aux data.

g. Out-of-Coverage Indications (OCI) shall be eliminated or the MLS restricted for use.

h. Identification shall be correct and distinct throughout the coverage area. Decoded basic data word 6 shall match transmitted Morse code identification.

(2) PFN = 0.087 degree at the MLS reference point for a standard 3.0 degree angle. For angles above 3.00 degrees by a factor of (0.087 + .0145 per degree)

(3) The CMN limit shall not exceed ± 0.10 degree in any coverage region within ± 10 degrees of runway centerline extended nor exceed ± 0.20 degree in any other region within coverage.

c. DME. The DME shall be evaluated as a DME/N throughout all areas of coverage.

d. Degradation Factors.

(1) Azimuth sited along runway centerline:

(a) With distance: The PFE and PFN limits, expressed in angular terms along the runway centerline, are 1.2 times the value at the ARD to a maximum of 0.25 degree at 20 NM from the ARD.

(b) With azimuth angle: The PFE and PFN limits expressed in angular terms at ± 40 degrees azimuth angle are 1.5 times the value on the extended runway centerline at the same distance from the ARD, to a maximum of 0.25 degree.

(c) With elevation angle below 9.0 degrees, no degradation allowed. From + 9 degrees to + 15 degrees, by a factor of 1.5 for the PFE and PFN limits to a maximum of 0.5 degree.

(2) Offset azimuth, co-located azimuth with elevation, and heliports:

(a) With distance: The PFE and PFN limits, expressed in angular terms along the procedural azimuth, are 1.2 times the value at the MAP to a maximum of 0.50 degree at 20 NM from the ARD.

(b) With azimuth angle: The PFE and PFN limits expressed in angular terms at ± 40 degrees azimuth angle, are 1.5 times the value on the extended runway centerline at the same distance from the MAP to a maximum of 0.5 degree.

(c) With elevation angle from + 9 degrees to + 15 degrees, by a factor of 1.5 for the PFE and PFN limits.

(3) Elevation:

(a) With distance: The PFE and PFN limit, expressed in angular terms along the runway centerline, are 1.2 times the value at the ARD.

(b) With azimuth angle: The PFE and PFN limits expressed in angular terms at ± 40 degrees azimuth angle are 1.5 times the value on the extended runway centerline at the same distance from the ARD.

(c) With increasing elevation angles: The PFE and PFN limits are degraded linearly from + 3 degrees to + 15 degrees, by a factor of 2.0 times the value at the ARD.

(d) With decreasing elevation angle: The PFE and PFN limits from + 3 degrees (or 60 percent of the MGP, whichever is less) to the coverage extreme are degraded linearly by a factor of 3 times the value at the ARD.

e. Basic Data Words (BDW) are associated with the operation of the landing guidance system. Essential basic data words are 1, 2, 3, 4, and 6.

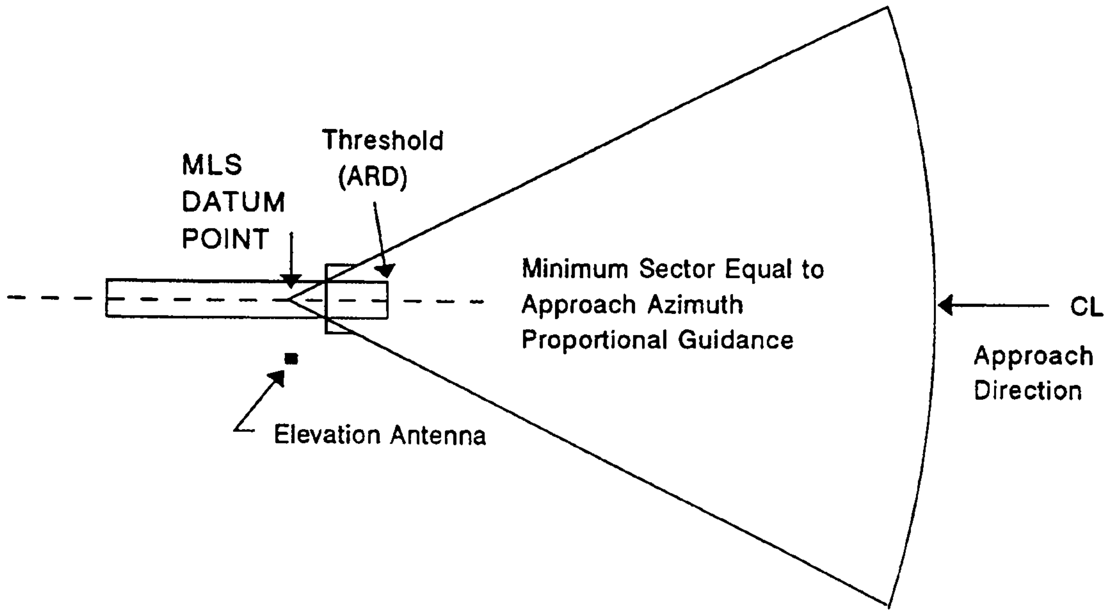
f. Auxiliary Data Words (Aux Data) provides information used for RNAV approaches. Essential aux data words are 1, 2, and 3. Facilities sited to support Category II/III autoland or RNAV curved approach procedures shall radiate correct aux data.

g. Out-of-Coverage Indications (OCI) shall be eliminated or the MLS restricted for use.

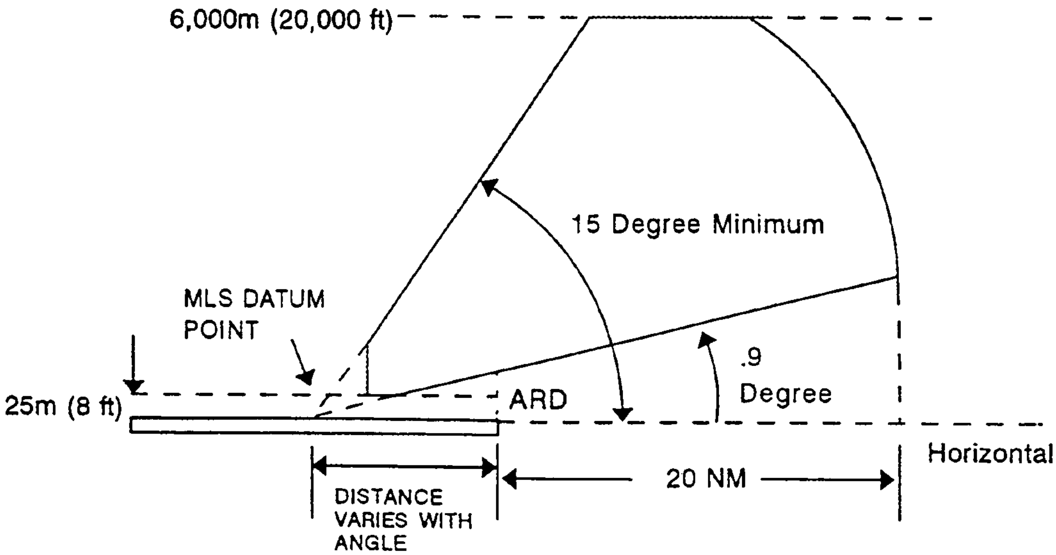
h. Identification shall be correct and distinct throughout the coverage area. Decoded basic data word 6 shall match transmitted Morse code identification.

Figure 220-2

APPROACH ELEVATION COVERAGE
HORIZONTAL COVERAGE



VERTICAL COVERAGE



MLS POINTS AND ZONES

Figure 220-3

STANDARD MLS

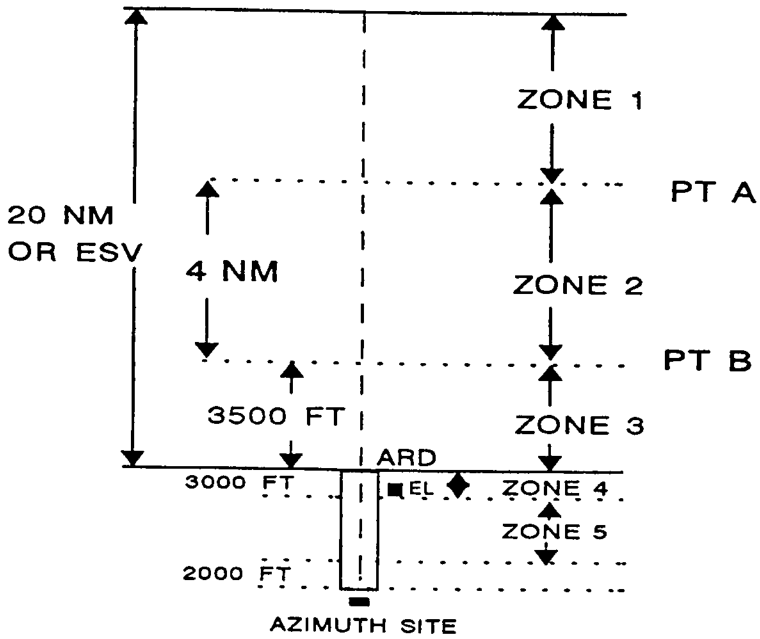
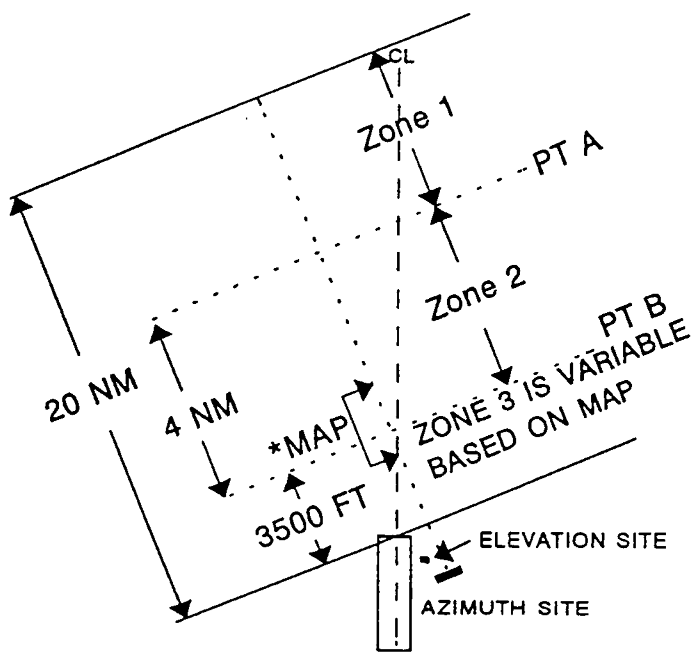


Figure 220-4

OFFSET MLS



* MAP IS VARIABLE BASED ON DECISION HEIGHT.

MLS POINTS AND ZONES, CONTINUED

Figure 220-5

CO-LOCATED MLS

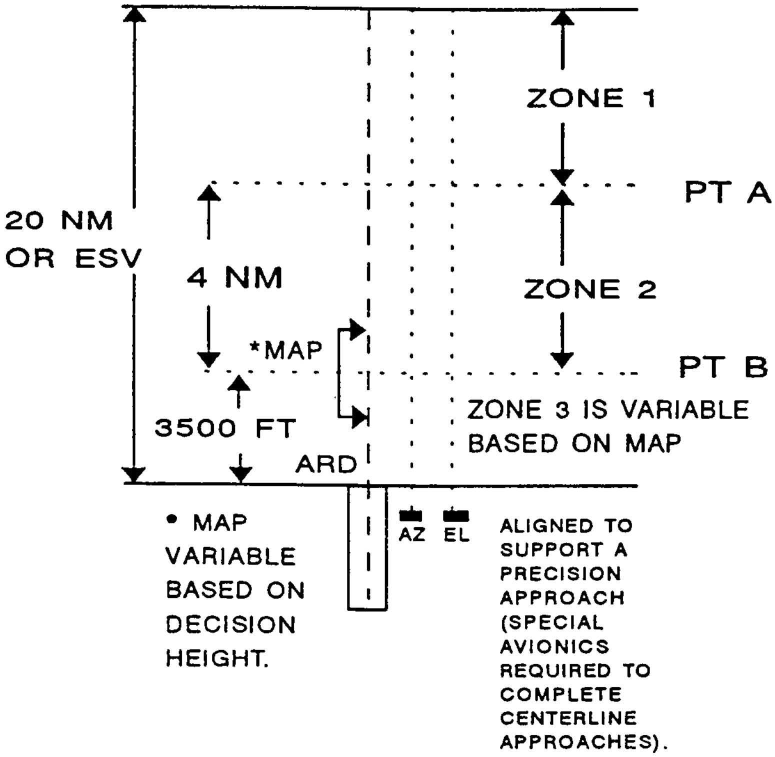
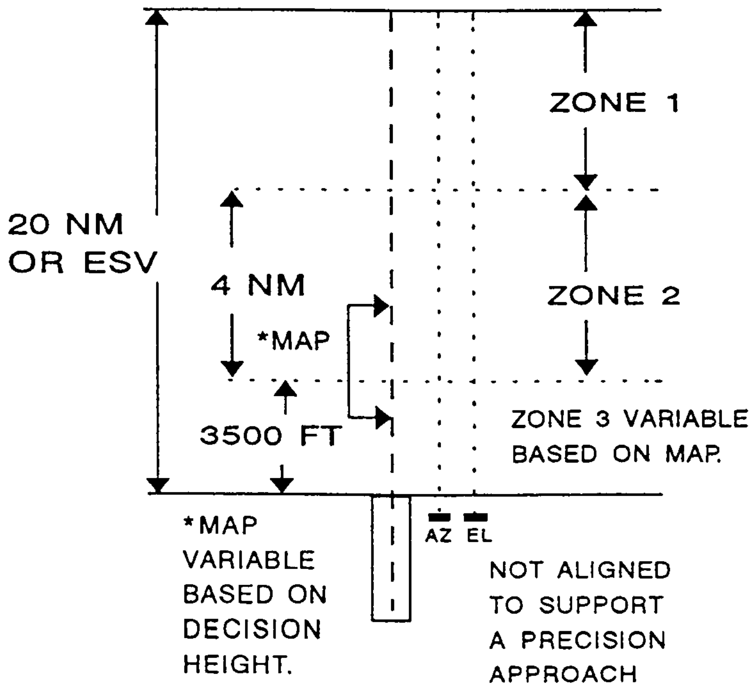


Figure 220-6

POINT IN SPACE MLS



MLS POINTS AND ZONES, CONTINUED

Figure 220-5

CO-LOCATED MLS

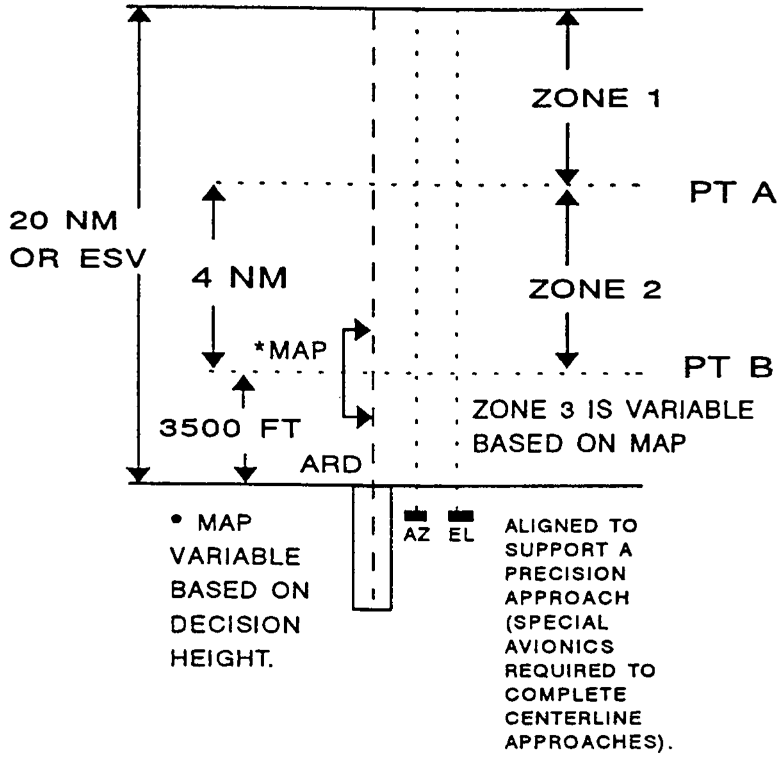
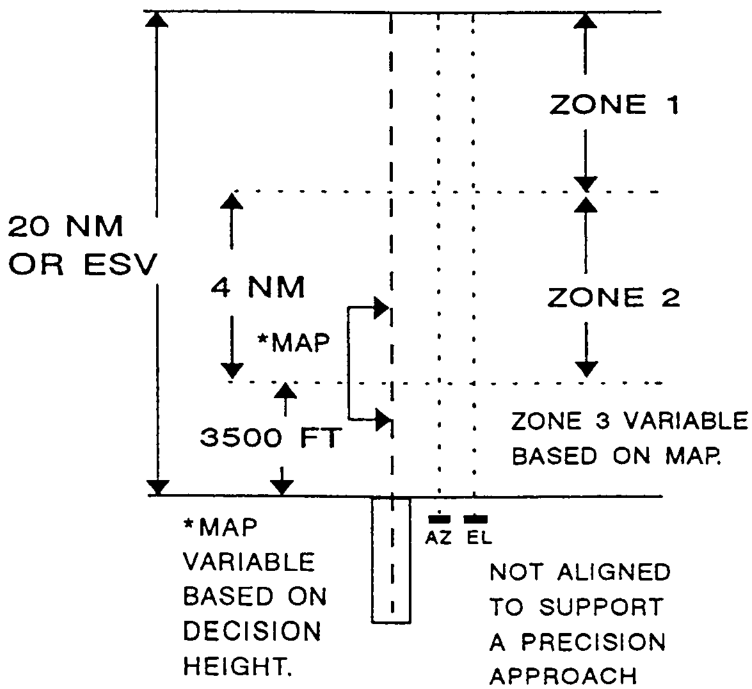


Figure 220-6

POINT IN SPACE MLS



SECTIONS 221 - 299

RESERVED

CHAPTER 300. SUPPLEMENTAL INFORMATION

SECTION 301. GLOSSARY OF ABBREVIATIONS, ACRONYMS, DEFINITIONS, AND SYMBOLS

301.1 Definitions and Symbols. The use of italics within a definition denotes another definition contained within this section.

Actual Glidepath Alignment or Actual Glidepath Angle. The straight line arithmetic mean of all deviations around the *on-path* position derived in ILS zone 2.

Actual Course (Alignment). The straight line arithmetic mean of all deviations around the *on-course* position derived from the area in which alignment was taken.

AFIS Corrected Error Trace. A graphical presentation of deviation about the mean of all points measured in ILS Zone 2 for glidepaths and zones 2 and 3 for localizers.

Automatic Gain Control (AGC). A process of electronically regulating the gain in the amplification stages of a receiver so that the output signal tends to remain constant though the incoming signal may vary in strength.

AGC Current or Voltage. A current or voltage responding to the action of the AGC circuit that may be interpreted in terms of signal intensity.

Air Traffic Control Radar Beacon System (ATCRBS). The general term of the ultimate in functional capability afforded by several automation systems. Each differs in functional capabilities and equipment. ARTS IA, ARTS II, ARTS III, and ARTS IIIA (see AIM).

Airway/Federal Airway. A control area or portion thereof established in the form of a corridor, the centerline of which is defined by navigational aids (refer to FAR Part 71, AIM).

Alignment. Coincidence of a positional or directional element with its nominal reference.

Alignment, Azimuth. The azimuth or actual magnetic bearing of a course.

Alignment, Elevation. The actual angle above a horizontal plan originating at a specific point of a course used for altitude guidance.

Alignment Error. The angular or linear displacement of a positional or directional element from its normal reference.

Alignment Error, Azimuth. The difference in degrees between the position of a selected course and the correct magnetic azimuth for this course.

Note: The error is positive when the course is clockwise from the correct azimuth.

Alignment Error, Elevation. The difference in degrees between the measured angle of the course and the correct angle for the course.

Note: The error is positive when the course is above the correct angle.

ALTITUDES:

Absolute Altitude. The altitude of the aircraft above the surface it is flying (AC 00-6A). It may be read on a radio/radar altimeter.

Calibrated Altitude. Indicated altitude corrected for static pressure error, installation error, and instrument error.

Indicated Altitude. The altitude as shown by an altimeter on a pressure or barometric altimeter. It is altitude as shown uncorrected for instrument error and uncompensated for variation from standard atmospheric conditions (AIM).

Pressure Altitude. Altitude read on the altimeter when the instrument is adjusted to indicate height above the standard datum plane (29.92" Hg.)(AC 61-27 latest revision).

True Altitude. The calibrated altitude corrected for nonstandard atmospheric conditions. It is the actual height above mean sea level (AC 61-27 and AFM 51-37).

Ampere. A unit of electric current such as would be given with an electromotive force of one volt through a wire having a resistance of one OHM. See Symbols. See Crosspointer.

Amplitude (Peak). The maximum instantaneous value of a varying voltage or current measured as either a positive or negative value.

Anomalous Propagation. Weather phenomena resulting in a layer in the atmosphere capable of reflecting or refracting electromagnetic waves either toward or away from the surface of the earth.

Angle Voltage. The alignment points of the azimuth and elevation electronic cursors are expressed in angle voltage or dial divisions.

Antenna. A device used to radiate or receive electromagnetic signals.

Antenna Reflector. That portion of a directional array, frequently indirectly excited, which reduces the field intensity behind the array and increases it in the forward direction.

Approach Azimuth. Equipment which provides lateral guidance to aircraft in the approach and runway regions. This equipment may radiate the Approach Azimuth function or the High Rate Approach Azimuth function along with appropriate basic and auxiliary data.

Approach Elevation. The equipment which provides vertical guidance in the approach region. This equipment radiates the Approach Elevation function.

Approach Reference Datum (ARD). A point at a specified height located vertically above the intersection of the runway centerline and the threshold.

Area Navigation (RNAV). A method of navigation that permits aircraft operations on any desired course within the coverage of station referenced navigation signals or within the limits of self-contained system capability (AIM).

Area VOT. A facility designed for use on the ground or in the air. It may be located to provide the test signal to one or more airports.

Attenuation. The reduction in the strength of a signal, expressed in decibels (dB).

Average Course Signal. The course determined by drawing the mean of the maximum course deviations due to roughness and scalloping.

Azimuth. A direction at a reference point expressed as the angle in the horizontal plane between a reference line and the line joining the reference point to another point, usually measured clockwise from the reference line.

Auxiliary Data. Data, transmitted in addition to basic data, that provide facilities maintenance equipment siting information for use in refining airborne position calculations and other supplementary information.

Baseline Extension (Loran-C). The extension of the baseline beyond the master or secondary station. Navigation in this region may be inaccurate due to geometrical considerations resulting in ambiguous position solutions.

Basic Data. Data transmitted by the facilities maintenance equipment that are associated directly with the operation of the landing guidance system.

Bearing. The horizontal direction to or from any point usually measured clockwise from true north or some other reference point (see Non-Directional Beacon)(AIM).

Bends. Slow excursions of the course.

Bits per second (BPS). Refers to digital data transfer rate, usually by modem or direct cable.

Blind Speed. The rate of departure or closing of a target relative to the radar antenna at which cancellation of the primary target by MTI circuits in the radar equipment causes a reduction or complete loss of signal (AIM).

Blind Zones (Blind Spots). Areas from which radio transmissions and/or radar echoes cannot be received.

Broadband. Nonautomated signal processing.

Capture Effect. A system in which coverage is achieved by the use of two independent radiation field patterns spaced on separate carrier frequencies.

Change/Reversal in Slope of the Glidepath. A long term (1,500 feet or more) change in the direction of the *on-path* position as determined by the graphic averaging of the short term (roughness, high frequency scalloping) deviations as represented by the differential/corrected error trace.

Checkpoint. A geographical point on the surface of the earth whose location can be determined by reference to a map or chart.

Circular Polarization (CP). An electromagnetic wave for which the electronic and/or the magnetic field vector at a point describes a circle.

Note: Circular Polarization reduces or eliminates echoes from precipitation.

Clearance. The preponderance of the modulation signal appropriate to the area on one side of the reference line or point to which the receiver is positioned, over the modulation signal appropriate to the area on the other side of the reference line.

Clearance Guidance Sector. The volume of airspace, inside the coverage sector, within which the azimuth guidance information provided is not proportional to the angular displacement of the aircraft but is a constant fly-left or fly-right indication of the direction relative to the approach course the aircraft should proceed in order to enter the proportional guidance sector.

Close-in Courses. That portion of a course or radial which lies within 10 miles of the station.

Code Train. A series of pulses of similar characteristics and specific spacing. Applicable to the group of pulses transmitted by a transponder each time it replies to an interrogator.

Common Digitizer Data Reduction Program (CD). A computer data recording of raw narrowband radar data (minimal filtering ability is provided).

Cone of Ambiguity. Airspace over a VOR or TACAN station, conical in shape, in which the To/From ambiguity indicator is changing positions.

Control Motion Noise (CMN). Those fluctuations in the guidance which affect aircraft attitude, control surface, column motion, and wheel motion during coupled flight but do not cause aircraft displacement from the desired course or glidepath.

Cooperating Aircraft. Aircraft which cooperate by flying courses required to fulfill specific portions of the flight inspection and which meet the requirements for a small aircraft.

Cosecant-Squared Beam. A radar beam pattern designed to give approximately uniform signal intensity for echoes received from distant and nearby objects. The beam intensity varies as the square of the cosecant of the elevation angle.

Crosspointer (Deflection Indicator Current (ICAO)). An output current proportional to: ILS--Difference in depth of modulation measured in microamperes. VOR/VORTAC/TAC -- The difference in phase of two transmitted signals measured in degrees of two audio navigation components for a given displacement from a navigation aid.

Course Coincidence. The measured divergence of the designated radials of two adjacent facilities in the airway structure. (ICAO Document 8071).

Course Displacement. The difference between the actual course alignment and the correct course alignment. (ICAO Document 8071).

Course Error. The difference between the course as determined by the navigational equipment and the actual measured course to the facility. This error is computed as a plus or minus value, using the actual measured course to the facility as a reference.

Course Line Computer. Airborne equipment which accepts bearing and distance information from receivers in an aircraft, processes it, and presents navigational information enabling flight on courses other than directly to or from the ground navigation aid being used. (Used in Area Navigation--RNAV.)

Course Roughness. Rapid irregular excursions of the course usually caused by irregular terrain, obstructions, trees, power lines, etc.

Course Scalloping. Rhythmic excursions of the electromagnetic course or path.

Course Width (Course Sensitivity). The angular deviation required to produce a full-scale course deviation indication of the airborne navigation instrument.

Coverage. The designated volume of airspace within which a signal-in-space of specified characteristics is to be radiated.

Cycle Skip. The receiver uses the incorrect cycle of the 100 kHz carrier of the Loran-C signal, for time measurements. Normally the third cycle of a given carrier pulse is used for time measurements. Each cycle slip will result in a 10-microsecond error in time measurement and a corresponding error in navigation.

Dedicated TRIAD. Three specific Loran-C stations from one CHAIN. Dedicated TRIAD selection is utilized to ensure that receiver positioning is determined only by these stations.

Designed Procedural Azimuth. The azimuth determined by the procedure specialist that defines the desired position of a course or bearing.

DF Course (Steer). The indicated magnetic direction of an aircraft to the DF station and the direction the aircraft must steer to reach the station.

DF Fix. The geographical location of an aircraft obtained by the direction finder.

Difference in Depth of Modulation (DDM). The percentage modulation of the larger signal minus the percentage modulation of the smaller signal.

Discrepancy. Any facility operating parameter which is not within the given tolerance values (prescribed in the U.S. Standard Flight Inspection Manual) as determined by flight inspection measurements.

Displaced Threshold. A threshold located on the runway at a point other than the designated beginning of the runway (AIM).

Distance Measuring Equipment (DME). Electronic equipment used to measure, in nautical miles, the slant range of the aircraft from the navigation aid. (AIM)

Distance Measuring Equipment/Precision (DME/P). The range function associated with the MLS. It is a precision distance measuring equipment providing accurate range (20 to 40 feet at a 2-sigma probability).

Doppler VOR (DVOR). VOR using the Doppler frequency shift principle.

Dual-Frequency Glidepath System. An ILS glidepath in which coverage is achieved by the use of two independent radiation field patterns spaced on separate carrier frequencies within the particular glidepath channel, e.g., Capture Effect Glidepath.

Dual-Frequency Localizer System. A localizer system in which coverage is achieved by the use of two independent radiation frequencies within the particular localizer VHF channel.

Envelope to Cycle Discrepancy (ECD). The discrepancy between the desired and actual zero phase crossing at the end of the third cycle of the Loran-C 100 kHz carrier pulse.

Essential Data. Essential data words are Basic Data Words 1, 2, 3, 4, and 6; and Auxiliary Data Words A1, A2, and A3.

Expanded Service Volume (ESV). That additional volume of airspace beyond the service volume requested by the FAA's Air Traffic Service or procedure specialist and approved by frequency management of the Airway Facilities Division and flight inspection for operational use.

/F. Flight Management System (FMS) and Electronic Flight Instrument System (EFIS) equipped aircraft with /E capability having a "Special Aircraft and Aircrew Authorization" issued by the FAA.

Facility (Flight Facility). Any ground placed electronic equipment used to assist pilots in air navigation, landing approaches, or to direct air traffic movements. Flight facilities include NAVAID's, communications, and traffic control facilities.

Feed Horn. Radar antenna focal point. Also reference point in antenna elevation measurements.

Fixed Map. A background map on the radar display produced by one of the following methods:

(1) Engraved marks on an overlay illuminated by edge lighting
(2) Engraved fluorescent marks on an overlay illuminated by means of ultraviolet light.
(3) Projected on the display by means of film and a projector mounted above and in front of the scope.

(4) Electronically mixed into the display as generated by a "mapper" unit

Flag (Flag Alarm). A warning device in certain airborne navigation equipment and flight instruments indicating: (1) instruments are inoperative or otherwise not operating satisfactorily, or (2) signal strength or quality of the received signal falls below acceptable values. (AIM)

Flag Alarm Current. The d.c. current flowing in the Flag Alarm Circuit, usually measured in microamperes, which indicates certain characteristics of the modulation of the received signal.

Flight Inspection (Flight Check). Inflight investigation and evaluation of air navigation aids and instrument flight procedures to ascertain or verify that they meet established tolerances and provide safe operations for intended use.

Note: *Flight checked* describes the procedure to accomplish the function of flight inspection. The two terms are interchangeable.

Geometric Dilution of Precision (GDOP). A factor used to express navigational error at a position fix caused by divergence of the hyperbolic lines of position as the aircraft's receiver distance from the baseline increases. The larger the GDOP, the larger the standard deviation of position errors.

Glidepath. See: ILS Glidepath.

Glidepath Angle. The angle between the downward extended straight line extension of the ILS glidepath and the horizontal.

Glidepath Structure. Characteristics of a glidepath including bends, scalloping, roughness, and width.

Glide Slope. A facility which provides vertical guidance for aircraft during approach and landing.

Glide Slope Intercept Altitude. The true altitude (MSL) proposed or published in approved let-down procedures at which the aircraft intercepts the glidepath and begins descent. (FAA Order 1000.15 latest revision)

Graphical Average Path. The average path described by a line drawn through the mean of all crosspointer deviations. This will usually be a curved line which follows long-term trends (1,500 feet or greater) and averages shorter term deviations.

Ground Point of Intercept (GPI). A point in the vertical plan on the runway centerline at which it is assumed that the *downward straight line extension* of the glide path intercepts the runway approach surface baseline. (FAA Order 8260.3 latest revision)

Group Repetition Interval (GRI). The time interval (microseconds divided by 10) between one group of 100 kHz carrier pulses and the next, from any transmitter within a Loran-C CHAIN. All stations in a specific CHAIN use the same GRI.

Hertz (Hz). A unit of frequency of electromagnetic waves which is equivalent to one cycle per second. See Symbols in this chapter.

Kilohertz (kHz). A frequency of 1000 cycles per second.

Megahertz (MHz). A frequency of one million cycles per second.

Gigahertz (GHz). A frequency of one billion cycles per second.

Hole (Null). An area of signal strength below that required to perform the necessary function or furnish the required information, which is completely surrounded by stronger signal areas of sufficient strength to perform required functions.

ILS--Back-Course Sector. The *course sector* which is the appropriate reciprocal of the front *course sector.*

ILS--Commissioned Angle--Glide Slope. The glidepath angle calculated by a qualified procedure specialist which meets obstruction criteria (FAA Order 8260.3 latest revision). This nominal angle may be increased to meet additional criteria, i.e., engineering, noise abatement, site deficiencies, etc.

ILS--Commissioned Width--Localizer. The nominal width of a localizer. In practice the width is computed by using the criteria prescribed in Section 217 of FAA Order 8200.1 (latest revision).

ILS--Course Sector. A sector in a horizontal plane containing the course line and limited by the loci of points nearest to the course line at which 150uA is found.

ILS--Differential Corrected Trace. The trace on the recording which is the algebraic sum of the Radio Telemetering Theodolite (RTT) crosspointer (DDM) and the aircraft receiver crosspointer (DDM) and which is produced by the differential amplifier within the airborne Theodolite Recording System.

ILS--Downward Straight Line Extension. The mean location of the ILS Glidepath in zone 2.

ILS--Facility Reliability. The probability that an ILS ground installation radiates signals within the specified tolerances.

ILS--Front Course Sector. The course sector which is situated on the same side of the localizer as the runway.

ILS--Glidepath. The locus of points in the vertical plane (containing the runway centerline) at which the DDM is zero, which of all such loci is the closest to the horizontal plane.

Note: Offset ILS's do not contain the runway centerline.

ILS--Glidepath Sector. The sector in the vertical plane containing the ILS glidepath at which 150uA occurs.

Note: The ILS glidepath sector is located in the vertical plane containing the localizer *on-course* signal and is divided by the radiated glidepath called upper sector and lower sector, referring respectively to the sectors above and below the path.

ILS--Glidepath Sector Width (Normal Approach Envelope). The width of a sector in the vertical plane containing the glidepath and limited by the loci of points above and below the path at which reading of 150uA is obtained.

ILS--Half Course Sector. The sector, in a horizontal plan containing the course line and limited by the loci of points nearest the course line at which 75uA occurs.

ILS--Localizer Back Course Zone 1. The distance from the coverage limit to 4 miles from the localizer antenna.

ILS--Localizer Back Course Zone 2. From 4 miles from the localizer antenna to 1 mile from the localizer antenna.

ILS--Localizer Back Course Zone 3. One mile from the localizer antenna to 3,000 feet from the localizer antenna.

ILS--Localizer Clearance Sector 1. From 0^{o} to 10^{o} each side of the center of the localizer *on-course*.

ILS--Localizer Clearance Sector 2. From 10^{o} to 35^{o} each side of the center of the localizer *on-course*.

ILS--Localizer Clearance Sector 3. From 35^{o} to 90^{o} each side of the center of the localizer *on-course*.

ILS--Localizer Course Sector Width. The sum of the angular distances either side of the center of the course required to achieve full scale (150uA) crosspointer deflection.

ILS--Lowest Coverage Altitude (LCA). That altitude which is final approach fix altitude, glidepath intercept altitude, or 500 feet above all obstructions, whichever is higher.

ILS--Performance Category I. An ILS which provides acceptable guidance information from the coverage limits of the ILS to the point at which the localizer course line intersects the glidepath at a height of 100 feet or less above the horizontal plane containing the runway threshold.

ILS--Performance Category II. An ILS which provides acceptable guidance information from the coverage limits of the ILS to the point at which the localizer course line intersects the glidepath at a point above the runway threshold.

ILS--Performance Category III. An ILS, which, with the aid of ancillary equipment where necessary, provides guidance information from the coverage limit of the facility to, and along, the surface of the runway.

ILS--Point "A". An imaginary point on the glidepath/localizer *on-course* measured along the runway centerline extended, in the approach direction, 4 nautical miles from the runway threshold.

ILS--Point "B". An imaginary point on the glidepath/localizer *on-course* measured along the runway centerline extended, in the approach direction, 3,500 feet from the runway *threshold.*

ILS--Point "C". A point through which the *downward extended straight portion* of the glidepath (at the commissioned angle) passes at a height of 100 feet above the horizontal plane containing the *runway threshold*.

Note: Localizer only, LDA's and SDF only facilities, Point C is the missed approach point.

ILS Point "D". A point 12 feet above the runway centerline and 3,000 feet from the runway threshold in the direction of the localizer.

ILS Point "E". A point 12 feet above the runway centerline and 2,000 feet from the stop end of the runway in the direction of the *runway threshold.*

ILS Point "T". A point at specified height located vertically above the intersection of the runway centerline and the *runway threshold* through which the *downward extended straight line* portion of the ILS glidepath passes.

ILS Reference Datum. Same as ILS Point "T".

ILS--Zone 1. The distance from the coverage limit of the localizer/glidepath to Point "A" (four miles from the *runway threshold).*

ILS--Zone 2. The distance from Point "A" to Point "B".

ILS--Zone 3. CAT I - The distance from Point "B" to Point "C" for evaluations of Category I ILS. CAT II and III - The distance from Point "B" to the *runway threshold* for evaluations of Category II and III facilities.

ILS--Zone 4. The distance from runway threshold to Point "D".

ILS--Zone 5. The distance from Point "D" to Point "E".

In-Phase. Applied to the condition that exists when two signals of the same frequency pass through their maximum and minimum values of like polarity at the same time.

Integrity. That quality which relates to the trust which can be placed in the correctness of the information supplied by the facility.

Integrators. Received target enhancement process used in primary radar receivers.

Interrogator. The ground-based surveillance radar transmitter-receiver which normally scans in synchronism with a primary radar, transmitting discrete radio signals which repetitiously request all transponders, on the mode being used, to reply. The replies are displayed on the radar scope. Also applied to the airborne element of the TACAN/DME system. (AIM)

Investigator-in-Charge (IIC). Person responsible for on-site aircraft investigation procedure.

Joint Acceptance Inspection (JAI). Inspection at culmination of facility installation and preparation. System is technically ready for commissioning after successful JAI.

Joint Use. For this document, refer to radar sites used by both the FAA and military.

Line-of-Position (LOP). LOP is a hyperbolically curved line defined by successive but constant time difference measurements using the signals from two Loran-C transmitters. Two LOP's from two station pairs define the location of a receiver and establish a position fix.

Local Area Monitor (LAM). A stationary receiver designed to monitor and record Loran-C signals and time difference (TD) data. TD information obtained by this unit is used for calculating receiver TD calibration values.

Localizer Type Directional Aid (LDA). A facility of comparable utility and accuracy to a LOC, but which is not part of a full ILS and may not be aligned with the runway. (FAA Order 8260.3, latest revision)

Localizer (LOC). The component of an ILS which provides lateral guidance with respect to the runway centerline. (FAA Order 8260.3, latest revision)

Localizer Zones. See *ILS-Zones* or *ILS-Localizer Back Course Zones*

Lock-On. The condition during which usable signals are being received by the airborne equipment and presentation of steady azimuth and/or distance information starts.

Loran-C CHAIN. Loran-C stations are grouped into sets of stations called CHAINs. Each CHAIN consists of a master station and two or more secondary stations that repeat transmissions over a specific period of time (see GRI).

Loran Signal Evaluation System (LSES). The LSES is a Loran-C receiver and a time difference data device used to evaluate approach sites. The device determines if usable signals are present and establishes the time difference relationship with the local area monitor.

Loran-C Time Difference (TD). The elapsed time, in microseconds, between the arrival of two signals.

Lowest Coverage Altitude (LCA). See *ILS-Lowest Coverage Altitude (LCA).*

Maximum Authorized Altitude (MAA). A published altitude representing the maximum usable altitude or flight level for an airspace structure or route segment. It is the highest altitude on a Federal airway, Jet route, area navigation low or high route, or other direct route for which an MEA is designated in FAR Part 95, at which adequate reception of navigation and signals is assured.

Maximum Error. The maximum amplitude of course alignment from zero, either in the clockwise or counterclockwise direction.

Microampere(s). (Microamps)--One millionth of an ampere (amp). In practice, seen on a pilot's omnibearing selector (OBS), oscillograph recordings, and/or flight inspection meters, as a deviation of the aircraft's position in relation to a localizer on-course (zero DDM) signal or glidepath on-path (zero DDM) signal, e.g., "5 microamperes (uA) right" (localizer); "75uA low" (glidepath). See Crosspointer and Symbols in this section.

Microwave Landing System (MLS). The international standard microwave landing system.

Milliampere (mA). One one-thousandth of an ampere.

Minimum Crossing Altitude (MCA). The lowest altitude at certain fixes at which an aircraft must cross when proceeding in the direction of a higher minimum en route IFR altitude (MEA). (AIM)(See Minimum En Route IFR Altitude)

Minimum Descent Altitude (MDA). The lowest altitude, expressed in feet above mean sea level, to which descent is authorized on final approach or during circle-to-land maneuvering in execution of a standard instrument approach procedure where no electronic glidepath is provided. (AIM)

Minimum En Route IFR Altitude (MEA). The lowest published altitude between radio fixes which assures acceptable navigational signal coverage and meets obstacle clearance requirements between those fixes. The MEA prescribed for a Federal airway or segment thereof, area navigational low or high route, or other direct route applies to the entire width of the airway, segment, or route between the radio fixes defining the airway, segment, or route. (AIM) (FAR Parts 91 and 95).

Minimum Glide Path (MGP). The lowest angle of descent along the zero degree azimuth that is consistent with published approach procedures and obstacle clearance criteria.

Minimum Holding Altitude (MHA). The lowest altitude prescribed for a holding pattern which assures navigational signal coverage, communications, and meets obstacle clearance requirements. (AIM)

Minimum Obstruction Clearance Altitude (MOCA). The lowest published altitude in effect between radio fixes on VOR airways, off-airway routes, or route segments which meets obstacle clearance requirements for the entire route segment and which assures acceptable navigation signal coverage only within 25 statute miles (22NM) of a VOR. (AIM) (Refer to FAR Parts 91 and 95)

Minimum Radar Range. The shortest distance from the radar at which the aircraft can be clearly identified on each scan of the radar antenna system.

Minimum Reception Altitude (MRA). The lowest altitude at which an intersection can be determined. (AIM) (Refer to FAR Part 95)

Minimum Vectoring Altitude (MVA). The lowest MSL altitude at which an IFR aircraft will be vectored by a radar controller, except as otherwise authorized for radar approaches, departures and missed approaches. The altitude meets IFR obstacle clearance criteria. It may be lower than the published MEA along an airway or J-route segment. It may be utilized for radar vectoring only upon the controllers' determination that an adequate radar return is being received from the aircraft being controlled. Charts depicting minimum vectoring altitudes are normally available only to the controllers and not to pilots. (AIM)

Missed Approach Point (MAP). A point prescribed in each instrument approach procedure at which a missed approach procedure shall be executed if the required visual reference does not exist. (AIM: See Missed Approach and Segments of an Instrument Approach Procedure.)

MLS Approach Reference Datum. A point at a specified height located vertically above the intersection of the runway centerline and the threshold.

MLS Auxiliary Data. Data, transmitted in addition to basic data, that provide facilities maintenance equipment siting information for use in refining airborne position calculations and other supplementary information.

MLS Basic Data. Data transmitted by the facilities maintenance equipment that are associated directly with the operation of the landing guidance system.

MLS Coverage Sector. A volume or airspace within which service is provided by a particular function and in which the signal power density is equal to or greater than the specified minimum.

MLS Datum Point. The point on the runway centerline closest to the phase center of the approach elevation antenna.

MLS Function. A particular service provided by the MLS; e.g., approach azimuth guidance, approach elevation guidance, or basic data, etc.

MLS Mean Course Error. The mean value of the azimuth error along a specified radial of the azimuth function.

MLS Mean Glidepath Error. The mean value of the elevation error along a specified angle of the elevation function.

MLS Minimum Glidepath. The lowest angle of descent along the zero-degree azimuth that is consistent with published approach procedures and obstacle clearance criteria.

MLS-Point "A". An imaginary point on the minimum glidepath and commissioned azimuth radial, 4 nautical miles from the runway threshold.

MLS-Point "B". An imaginary point on the minimum glidepath and commissioned azimuth radial, 500 feet from the runway threshold.

MLS-Point "C". A point through which the downward extended straight portion of the glidepath passes at a height of 100 feet above the horizontal plane containing the runway threshold.

Note: Azimuth only facilities, Point C is the missed approach point.

MLS-Point "D". A point 12 feet above the runway centerline and 3,000 feet from the runway threshold in the direction of the azimuth station.

MLS-Point "E". A point 12 feet above the runway centerline and 2,000 feet from the stop end of the runway in the direction of the runway threshold.

MLS Proportional Guidance Sector. The volume of airspace within which the angular guidance information provided by a function is directly proportional to the angular displacement of the airborne antenna with respect to the zero angle difference.

MLS Reference Point. The point at which flight inspection begins to apply facility budget error tolerances. This will normally be either the ARD or MAP.

Mode. The letter or number assigned to a specific pulse spacing of radio signals transmitted or received by ground interrogator or airborne transponder components of the Air Traffic Control Radar Beacon System (ATCRBS). Mode A (military Mode 3), Mode C (altitude reporting), and Mode S (data link) are used in air traffic control. (See transponder, interrogator, radar.) (AIM)

> ICAO-Mode (SSR) Mode. The letter or number assigned to a specific pulse spacing of the interrogation signals transmitted by an interrogator. There are five modes: A, B, C, D, and M--corresponding to five different interrogation pulse spacings.

Moving Target Detection (MTD). Type of moving target detection system (like MTI) based on digital storage map techniques. Used in newer primary radars.

Moving Target Indicator (MTI). Electronic circuitry that permits the radar display presentation of only targets which are in motion. A partial remedy for ground clutter.

MTI Reflector. A fixed device with electrical characteristics of a moving target which allows the demonstration of a fixed geographic reference on a MTI display. (Used to align video maps, azimuth reference, etc.)

Narrowband Radar Display. Computer generated display of radar signals.

National Flight Data Center (NFDC). A facility in Washington, D.C., established by FAA to operate a central aeronautical information service for the collection, validation, and dissemination of aeronautical data in support of the activities of government, industry, and the aviation community. The information is published in the National Flight Data Digest. (AIM: See National Flight Data Digest.)

National Transportation Safety Board (NTSB). Office responsible for aircraft accident investigations.

NAVAID. Any facility used in, available for use in, or designated for use in aid of air navigation, including landing areas, lights, any apparatus or equipment for disseminating weather information, for signaling, for radio direction finding, or for radio or other electronic communication, and any other structure or mechanism having a similar purpose for guiding or controlling flight in the air or the landing or takeoff of aircraft. (Re: Federal Aviation Act of 1958, as amended.) (AIM)

Nondirectional Beacon/Radio Beacon (NDB). An L/MF or UHF radio beacon transmitting nondirectional signals whereby the pilot of an aircraft equipped with direction finding equipment can determine his bearing to or from the radio beacon and "home" on or track to or from the station. When the radio beacon is installed in conjunction with the Instrument Landing System marker, it is normally called Compass Locator. (AIM)

Nonprecision Approach Procedure/ Nonprecision Approach. A standard instrument approach procedure in which no electronic glide slope is provided; e.g., VOR, TACAN, NDB, LOC, ASR, LDA, or SDF approaches. (AIM)

Notices to Airmen/Publication. A publication designed primarily as a pilot's operational manual containing current NOTAM information (see Notices to Airmen - NOTAM) considered essential to the safety of flight, as well as supplement data to other aeronautical publications. (AIM)

Notices to Airmen/NOTAM. A notice containing information (not known sufficiently in advance to publicize by other means) concerning the establishment, condition, or change in any component (facility, service, or procedure of, or hazard in the National Airspace System) the timely knowledge of which is essential to personnel concerned with flight operations. (AIM)

a. NOTAM (D) - A NOTAM given (in addition to local dissemination) distant dissemination via teletype writer beyond the area of responsibility of the Flight Service Station. These NOTAMS will be stored and repeated hourly until canceled.

b. NOTAM (L) - A NOTAM given local dissemination by voice (teletypewriter where applicable), and a wide variety of means such as: TelAutograph, teleprinter, facsimile reproduction, hot line, telecopier, telegraph, and telephone to satisfy local user requirements.

c. FDC NOTAM A notice to airmen, regulatory in nature, transmitted by NFDC and given all-circuit dissemination.

d. ICAO NOTAM. A notice, containing information concerning the establishment, condition, or change in any aeronautical facility, service, procedure, or hazard, the timely knowledge of which is essential to personnel concerned with flight operations. (AIM)

Null. That area of an electromagnetic pattern where the signal has been intentionally canceled or unintentionally reduced to an unacceptable level.

Obstacle. An existing object, object of natural growth, or terrain at a fixed geographical location, or which may be expected at a fixed location within a prescribed area, with reference to which vertical clearance is or must be provided during flight operation. (AIM)

Obstacle Clearance. The vertical distance between the lowest authorized flight altitude and a prescribed surface within a specified area. (FAA Order 8260.19, latest revision)

Obstruction. An object which penetrates an imaginary surface described in FAR Part 77. (AIM) (Refer to FAR Part 77).

Omnibearing Selector (OBS). An instrument capable of being set to any desired bearing of an omnirange station and which controls a course deviation indicator.

On-Course. The locus of points in the horizontal plane in which a zero or on-course reading is received.

On-Path. Same as on-course but in the vertical plane. See ILS--Glidepath.

Operational Advantage. An improvement which benefits the users of an instrument procedure. Achievement of lower minimums or authorization for a straight-in approach with no derogation of safety are examples of an operational advantage. Many of the options in TERP's are specified for this purpose. For instance, the flexible final approach course alignment criteria may permit the ALS to be used for reduced visibility credit by selection of the proper optional course. (FAA Order 8260.3, latest revision)

Optimum Error Distribution. Best overall facility alignment error distribution to achieve maximum operational benefits (not necessarily a perfect balance of the errors).

Orbit Flight. Flight around a station at predetermined altitude(s) and constant radius.

Oscilloscope. An instrument for showing visually, graphic representations of the waveforms encountered in electrical circuits.

Out-of-Coverage Indication (OCI). A signal radiated into areas outside the intended coverage sector where required to specifically prevent invalid removal of an airborne warning indication flag in the presence of misleading guidance information.

Out of Tolerance Condition. See Discrepancy.

Path Following Error (PFE). The guidance perturbations which the aircraft will follow. It is composed of a path following noise and of the mean course error in the case of azimuth functions or the mean glidepath error in the case of elevation functions.

Path Following Noise (PFN). That portion of the guidance signal error which could cause aircraft displacement from the mean course line or mean glidepath as appropriate.

Planned View Display (PVD). A display presenting computer generated information such as alphanumerics or video mapping.

Polarization Error. The error arising from the transmission or reception of a radiation having a polarization other than that intended for the system.

Primary Area. The area within a segment in which full obstacle clearance is applied. (FAA Order 8260.3, latest revision)

Proportional Guidance Sector. The volume of airspace within which the angular guidance information provided by a function' is directly proportional to the angular displacement of the airborne antenna with respect to the zero angle reference.

Quadradar. Ground radar equipment named for its four presentations.

a. **Height Finding**
b. **Airport Surface Detection**
c. **Surveillance**
d. **Precision Approach**

/R. RNAV and transponder with altitude encoding capability.

Radar Bright Display Equipment (RBDE). Equipment at the ARTCC which converts radar video to a bright raster scan (TV type) display.

Radar Data Analysis Software (RDAS). A generic term referring to many types of terminal and en route radar data analysis tools. (COMDIG, RARRE, DRAM, etc.)

Radar Plan Position Indicator (RAPPI). Maintenance display used with CD-1 common digitizers.

Radar/Radio Detecting and Ranging. A device which, by measuring the time interval between transmission and reception of radio pulses and correlating the angular orientation of the radiated antenna beam or beams in azimuth and/or elevation, provides information on range, azimuth, and/or elevation of objects in the path of the transmitted pulses.

a. **Primary Radar.** A radar system in which a minute portion of a radio pulse transmitted from a site is reflected by an object and then received back at that site for processing and display at an air traffic control facility.

b. **Secondary Radar/Radar Beacon/ ATCRBS.** A radar system in which the object to be detected is fitted with cooperative equipment in the form of a radio receiver/transmitter (transponder). Radar pulses transmitted from the searching transmitter/receiver (interrogator) side are received in the cooperative equipment and used to trigger a distinctive transmission from the transponder. This reply transmission, rather than a reflected signal, is then received back at the transmitter/receiver site for processing and display at an air traffic control facility. (See Transponder, Interrogator.) (AIM)

c. **ICAO-Radar.** A radio detection device which provides information on range, azimuth, and/or elevation of objects.

(1) **Primary Radar.** A radar system which uses reflected radio systems.

(2) **Secondary Radar.** A radar system wherein a radio signal transmitted from a radar station initiates the transmission of a radio signal from another station.

Radar Resolution - Azimuth. The angle in degrees by which two targets at the same range must be separated in azimuth in order to be distinguished on a radar scope as individual returns.

Radar Resolution - Range. The distance by which two targets at the same azimuth must be separated in range in order to be distinguished on a radar scope as individual returns.

Radar Route. A flight path or route over which an aircraft is vectored. Navigational guidance and altitude assignments are provided by ATC. (See Flight Path, Route.) (AIM)

Receiver Autonomous Integrity Monitoring (RAIM). A technique whereby a civil GPS receiver/processor determines the integrity of the GPS navigation signals without reference to sensors or non-DoD integrity systems other than the receiver itself. This determination is achieved by a consistency check among redundant pseudorange measurements.

Range of Validity. Area around a local area monitor where published Loran-C receiver TD calibration values are valid.

Radial. A magnetic bearing extending from a VOR/VORTAC/TACAN navigation facility. (AIM)

Range, Azimuth, Radar, Reinforced Evaluator (RARRE). An IBM 9020 radar diagonistic program which is used to evaluate narrowband radar.

Real Time Quality Check (RTQC). Internally generated test target in automated target processing devices (common digitizers, etc.)

Receiver Check Point. A specific point designated and published, over which a pilot may check the accuracy of his aircraft equipment, using signals from a specified station.

Recorder Event Mark. A galvo mark on a recorder related to a position or time, required for correlation of data in performance analysis.

Reference Radial. A radial, essentially free from terrain and side effects, designated as a reference for measuring certain parameters of facility performance.

Reference Voltage (VOR Reference Voltage). A 30 Hz voltage derived in the reference phase channel of the aircraft VOR receiver.

RHO/THETA Position. Coordinate position described by distance and angle.

Ring-Around. A display produced on the scope by front, side, or back antenna lobes of the secondary radar system. It appears as a ring around the radar location and may occur when an aircraft transponder replies to ground interrogations while in close proximity to the antenna site.

Rotation (Correct Rotation). A condition wherein the transmitted azimuth angle increases in a clockwise direction.

Roughness. Rapid irregular excursions of the electromagnetic course or path.

Runway Environment. The runway threshold or approved lighting aids or other markings identifiable with the runway. (FAA Order 8260.3)

Runway Threshold. The beginning of that portion of the runway usable for landing. (AIM) (When used for flight inspection purposes, displaced threshold(s) or threshold mean the same thing.)

Scalloping. See Course Scalloping. (FAA Order 1000.15, latest revision)

Search (DME/TACAN). Rapid movement of the distance or bearing indicators during the period in which either is unlocked. (FAA Order 1000.15, latest revision)

Secondary Area. The area within a segment in which required Obstruction Clearance (ROC) is reduced as distance from the prescribed course is increased. (FAA Order 8260.3, latest revision)

Segment. The basic functional division of an instrument approach procedure. The segment is oriented with respect to the course to be flown. Specific values for determining course alignment, obstacle clearance areas, descent gradients, and obstacle clearance requirements are associated with each segment according to its functional purpose. (FAA Order 8240.3, latest revision)

Sensing (Correct Sensing). A condition wherein the ambiguity indicator gives the correct To/From indication.

Sensitivity Time Control (STC). Procedure used to vary receiver sensitivity with range. Gain is reduced as a function of decreasing range, in an attempt to make all radar replies uniform. (Gain would be maximum to maximum range in this event.)

Service Volume/SV. That volume of airspace surrounding a NAVAID within which a signal of usable strength exists and where that signal is not operationally limited by co-channel interference.

Note: For VOR/TACAN/DME and ILS, the following definitions are used:

a. Standard Service Volume (SSV) - That volume of airspace defined by the national standard.

b. Expanded Service Volume (ESV) - An approved service volume outside of the standard service volume.

c. Operational Service Volume (OSV) - The airspace available for operational use. It includes the following:

(1) The SSV excluding any portion of the SSV which has been restricted.

(2) The ESV.

Short-Term Excursions. Excursion characteristics of a navigation on-course or on-path signal which includes scalloping, roughness, and other aberrations but excludes bends.

Side Bands. The separated and distinct signals that are radiated whenever a carrier frequency is modulated. In terms of most air navigation facilities, double sidebands are present. This means that frequencies above and below the carrier frequency differing by the amount of the modulating frequencies are present. These sidebands contain intelligence for actuating navigation instruments.

Simplex. Single channel operation usually referred to at those sites using a single channel where dual channel (diplex) operation is available.

Splits. Two or more beacon targets generated from a single target reply. An undesirable condition due to problems in the beacon transmitter, antenna, propagation, aircraft transponder, or processing equipment.

Simplified Directional Facility/SDF. A NAVAID used for nonprecision instrument approaches. The final approach course is similar to that of an ILS localizer.

Slant Range. The line-of-sight distance between two points not at the same elevation.

Stagger. A feature used with primary MTI radar systems to vary the PRF at pre-selected intervals. This moves the inherent blind speed to a less troublesome value.

Standard VOT. A facility intended for use on the ground only (See VHF Omnidirectional test range).

Structure. Excursion characteristics of a navigation on-course or on-path signal which includes bends, scalloping, roughness, and other aberrations.

Structure Below Path. An angular measurement of clearance below path.

Subclutter Visibility. A performance characteristic of the system to detect a moving target in the presence of relatively strong ground clutter.

Symbols.

G	10^9 times (a unit); giga
M	10^6 times (a unit); mega
k	10^3 times (a unit); kilo
h	10^2 times (a unit); hecto
dk	10 times (a unit); deca
d	10^{-1} times (a unit); deci
c	10^{-2} times (a unit); centi
m	10^{-3} times (a unit); milli
μ	10^{-6} times (a unit); micro
n	10^{-9} times (a unit); nano
$\mu\mu$	10^{-12} times (a unit); micromicro
θ	Commissioned angle
Σ	Sum; Sum of; algebraic sum of:
$>$	Greater than:
$<$	Less than
$\geq$	Equal to or greater than:
$\leq$	Equal to or less than:
$=$	equals:
:	ratio; ratio of:
$\therefore$	therefore:

Symmetry. (ILS)—ICAO: Displacement sensitivity. A ratio between individual width sectors (90 Hz and 150 Hz) expressed in percent.

Systems Performance Analysis Rating (SPAR). A rating based on performance or expected performance. These ratings are related to flight inspection intervals as follows:

SPAR Class 1, 90-day interval; Class 2, 180-day interval; Class 3, 270-day interval.

TACAN Distance Indicator (TDI). A unit of airborne equipment used to indicate distance from a selected facility.

Target of Opportunity. An itinerant aircraft operating within the coverage area of the radar and which meets the requirements for a small aircraft as described in FAA Order 8200.1 (latest revision) Section 215.

Target Return. The return signal transmitted by a beacon-equipped aircraft in reply to the ground facility interrogator. Also, indication shown on a radar display resulting from a primary radar return.

Threshold. See Runway Threshold.

Touchdown Zone (TDZ). The first 3,000 feet of runway beginning at the threshold. (See FAA Order 8260.3, latest revision).

Touchdown Zone Elevation. The highest runway centerline elevation in the touchdown zone.

Tracking. Condition of continuous distance or course information.

Transponder. The airborne radar beacon receiver/transmitter portion of the Air Traffic Radar Beacon System (ATCRBS) which automatically receives radio signals from interrogators on the ground, and selectively replies with a specific reply pulse or pulse group only to those interrogations being received on the mode to which it is set to respond. (See Interrogator.) (AIM)

Trend. The general direction or incline of a segment of the glidepath which persists for a distance of 1,500 feet or more along the approach course.

Un-Lock. Condition at which the airborne interrogator (TACAN) discontinues tracking and starts search.

Usable Distance. The maximum distance at a specified altitude at which the facility provides readable identification and reliable bearing or glidepath information under average atmospheric condition.

Variable Voltage (VOR Variable Voltage). A 30 Hz voltage derived in the variable phase channel of the aircraft VOR receiver.

Vertical Angle. An angle measured upward from a horizontal plane.

VHF Omnidirectional test range (VOT). A radio transmitter facility in the terminal area electronic navigation systems, radiating a VHF radio wave modulated by two signals having the same phase relationship at all azimuths. It enables a user to determine the operational status of a VOR receiver. (See Standard VOT and Area VOT.)

Video Map. An electronic displayed map on the radar display that may depict data such as airports, heliports, runway centerline extensions, hospital emergency landing areas, NAVAIDs and fixes, reporting points, airway/route centerlines, boundaries, handoff points, special use tracks, obstructors, prominent geographic features, map alignment indicators, range accuracy marks, and minimum vectoring altitudes (AIM)

Visual Descent Point (VDP). The visual descent point is a defined point on the final approach procedure from which normal descent from the MDA to the runway touchdown point may be commenced, provided visual reference is established. (AIM)

VORTAC. A facility composed of azimuthal information from both VOR and TACAN, plus distance information of TACAN.

VOT—Standard. See Standard VOT.

VOT—Area Use. See Area VOT.

VOT Reference Point. A point on or above an airport at which the signal strength of a VOT is established and subsequently checked (applies to both standard and area VOTs).

Waveform. The shape of the wave obtained when instantaneous values of an a.c. quantity are plotted against time in rectangular coordinates.

Waveguide. A hollow pipe usually of rectangular cross section used to transmit or conduct RF energy.

Wavelength. The distance usually expressed in meters traveled by a wave during the timer interval of one complete cycle. Equal to the velocity divided by the frequency.

9960 Hz Voltage. A voltage derived from the VOR 9960 amplitude modulation by the reference channel of the VOR receiver. The 9960 Hz AM is a subcarrier which is frequency modulated by the 30Hz reference. Also referred to the 10 kHz subcarrier.

301.2 ABBREVIATIONS, ACRONYMS, AND LETTER SYMBOLS.

A	: Ampere
a.c.	: alternating current
AC	: advisory circular
ADF	: automatic direction finding
ADP	: automatic data processing
AER	: approach end of runway
AF	: Airway Facilities
AFB	: Air Force Base
AFC	: automatic frequency control
AFIS	: automated flight inspection system
AGC	: automatic gain control
AGL	: above ground level
AIM	: Airmen's Information Manual
air	: airborne
align	: alignment
ALS	: approach lighting system
ALSF	: approach lighting system with sequenced flashing lights
am.	: ammeter
AM	: amplitude modulation
amp	: Ampere
ANF	: air navigation facility
ant	: antenna
APPCON	: approach control
ARAC	: Army radar approach control
ARD	: approach reference datum
ARG	: auxiliary reference group
ARR	: automated flight inspection system reference radial
ARSR	: air route surveillance radar
ARTCC	: air route traffic control center
ARTS	: automated radar terminal system
ASOS	: automated surface aviation observing system
ASR	: airport surveillance radar
AT	: air traffic
ATC	: air traffic control
ATCRBS	: Air Traffic Control Radar Beacon System
ATIS	: Automatic Terminal Information Service
ATKER	: along track error
AVN	: Office of Aviation System Standards
AWOS	: automatic weather observation system
az	: azimuth
Az-El	: azimuth-elevation
BAz	: back azimuth horizontal guidance
BCM	: back course marker
bcn	: beacon
BFTA	: beacon false target analysis
BPS	: bits per second
BIT	: a digit in a binary coded decimal
BRITE	: brite radar indicator tower equipment
BUEC	: backup emergency communications
BW	: beam width
c	: centi ($=10^{-2}$)
C	: Celsius
°C	: degrees Celsius
C/A code	: coarse/acquisition code
cal	: calibrate, calibrated
CAS	: calibrated airspeed

CAT : category
CCW : counterclockwise
CD : common digitizer
CDI : course deviation indicator
CDU : control display unit
CHAIN : a group of Loran C stations
chan : channel
chg : change
CIC : combat information center
CL : centerline
Comm : Commission
CMN : control motion noise
COMDIG : common digitizer data reduction
COMLO : compass locator
CONUS : continental United States
COP : change-over-point
CTOL : conventional takeoff and landing
CP : circular polarization
CW : clockwise

d : deci ($=10^{-1}$)
DAME : distance azimuth measuring equipment
db decibel
dB/Hz : Decibel/Hertz
dbm : decibel referred to 1 milliwatt
DBRITE : Digital Bright Radar Indicator Tower Equipment
dbw : decibel referred to 1 watt
d.c. : direct current
DDM : difference in depth of modulation
DF : direction finding
DGPS : differential global positioning system
DH : decision height
disc : discrepancy
DME : distance measuring equipment
DME/P : distance measuring equipment/precision
DOD : Department of Defense
DOT : Department of Transportation
DPSK : differential phase shift keying
DVOR : doppler very high frequency omnidirectional range

E. : East
EARTS : en route automated radar tracking service
ECD : envelope to cycle discrepancy (difference)
ECOM : enroute communications
ECM : electronic counter measures
EFIS : electronic flight instrument system
e.g. : exempli gratia (for example)
el : elevation
ESV : expanded service volume
et al. : et alibi (and elsewhere; et alii (and others)
etc. : etcetera (and the rest; and so forth)

F : Fahrenheit
°F : degrees Fahrenheit
FAA : Federal Aviation Administration
FAC : final approach course
FAF : final approach fix
FANS : Future Air Navigation System (ICAO)
FAP : final approach point
FAR : Federal Aviation Regulations
FBWP : flyby waypoint
FIO : flight inspection office
FIP : Flight Inspection and Procedures (staff)
fig. : figure
FM : fan marker
FM : frequency modulation
FMS : flight management system
FOWP : flyover waypoint
freq : frequency
FSS : flight service station
FTC : fast time constant

G : giga ($=10^9$)
galv : galvanometers
GCA : ground contolled approach
GDOP : geometric dilution of precision
GHz : gigahertz
govt. : government
gnd : ground
GNSS : Global Navigation Satellite System
GPI : ground point of intercept
GRI : ground repetition interval
GS : glide slope
GSI : glide slope intercept altitude (Point)
GTC : gain time control

h : hecto (-10^2); hour
H : homer
HAA : height above airport elevation
HAT : height above touchdown
H-Class : high altitude
HDOP : horizontal dilution of precision
HF : high frequency
HF/DF : high frequency/direction finding
HFOM : horizontal figure of merit
HIRLS : high intensity runway lighting system
Hz : Hertz

IAC : initial approach course
IAF : initial approach fix
IAS : indicated airspeed
IC : intermediate course
ICAO : International Civil Aviation Organization

IIC : investigator-in-charge
ID : identification
i.e. : id est (that is)
IF : intermediate fix
IFIO : International Flight Inspection Office
IFR : Instrument Flight Rules
IFSS : international flight service stations
ILS : instrument landing system
IM : inner marker
INS : inertial navigation system
IO : input-output
IRU : inertial reference unit
ips : inches per second
ISLS : improved side lobe suppression

JAI : joint acceptance inspection
JSS : joint surveillance site

k : Kilo (=10^3)
kHz : kilohertz
KIAS : knots indicated airspeed
kn : knots
kW : kilowatt

LAM : local area monitor
lat. : latitude
LCA : lowest coverage altitude
L-Class : low altitude VOR
LDA : localizer directional aid
LDIN : lead-in lights
LEPP : live environment performance program
LF : low frequency
LMM : compass locator at middle marker
LOC : localizer
LOM : compass locator at outer marker
long. : longitude
LOP : line-of-position
Loran : long range navigation
LOS : line of site
LP : linear polarization
LRCO : limited remote communications outlet
LSES : loran signal evaluation system

m : meter
M : mega (=10^6)
mA : milliampere
MAA : maximum authorized altitude
MAHP : missed approach holding point
MALS : medium intensity approach lights—5,000 cp
MALSF : medium intensity approach lights; sequenced flashing lights
MALSR : same as MALSF; runway alignment indicator lights
MAP : missed approach point
MAWP : missed approach waypoint
MB : marker beacon
MCA : minimum crossing altitude
MDA : minimum descent altitude
MDP : MLS datum point
MEA : minimum en route altitude
MF : medium frequency
MHA : minimum holding altitude
Mhz : megahertz
MIRL : medium intensity runway lights
MLS : microwave landing system
MM : middle marker
MOCA : minimum obstruction clearance altitude
MRA : minimum reception altitude
MOPS : minimum operational performance standards
MRG : main reference group
MSG : minimum selectable glidepath
MSL : mean sea level
MTD : moving target detection
MTI : moving target indicator
MTR : mission test report
MSAW : minimum safe altitude warning
MUA : maximum usable altitude
mV : millivolt
MVA : minimum vectoring altitude
MVAR : magnetic variation

n : nano (=10^{-9})
N. : North
NA : not applicable or not authorized (when applied to instrument approach procedures)
NAS : National Airspace System
NAVAID : air navigation facility
NDB : nondirectional beacons
NFDC : National Flight Data Center
nm : nautical mile
NOTAM : Notice to Airmen
NRKM : nonradar keyboard multiplexer
NTSB : National Transportation Safety Board

OBS : omnibearing selector
OCI : out of coverage indication
ODALS : omnidirectional approach lighting system
OM : outer marker
orb. : orbit
OVLY XTKER : GPS overlay crosstrack error

PAPI : precision approach path indicator
P code : precision code
PAR : precision approach radar
PD : power density
PDOP : precision dilution of position

PE : permanent echo
PFE : path following error
PFN : path following noise
PIDP : programmable indicator data processor
PPI : plan position indicator
PPS : precise positioning service, P-code
PRF : pulse-repetition frequency
PRN : pseudo-range number
PT : procedure turn
PVD : plan view display

QARS : quick analysis of radar sites

RADAR or radar : radio range and detecting
RADES : Radar Evaluation Squadron (military)
RAG : range and azimuth gating
RAIL : runway alignment indicator light
RAIM : receiver autonomous integrity monitoring
RAPCON : radar approach control (USAF)
RAPPI : Radar plan position indicator
RARRE : range, azimuth radar reenforced evaluator
RATCC : radar approach control center (USN)
RBDE : radar bright display equipment
RCAG : remote, center air/ground communication facility
RCO : remote communication outlet
RDAS : radar data analysis software
RDH : runway datum height
rec : receiver
ref : reference
REIL : runway end identifier light
RF : radio frequency
RFI : radio frequency interference
RMI : radio magnetic indicator
RML : radar microwave link
RNAV : area navigation
RNP : required navigation performance
ROC : required obstruction clearance
RPI : runway point of intercept
RPM : revolutions per minute
RRP : runway reference point
RSCAN : radar statistical coverage analysis system
RTQC : real time quality check
R/T : receiver-transmitter
RTT : radio telemetering theodolite
RVR : runway visual range
RVV : runway visual value
RWY : runway

s : second
S. : South
SA : selective availability
SALS : short approach light system
SAVASI : simplified abbreviated visual approach slope indicator system
SDF : simplified directional facility
sec : second
SECRA : secondary radar
SER : stop end of runway
SIAP : standard instrument approach procedure
SID : standard instrument departure
SINE : site integration of NAS equipment
SLS : side lobe suppression
SNR : Signal-to-noise ratio
SNR-FS : Signal-to-noise ratio-field strength
SNR-PH : Signal-to-noise ratio-phase
SPAR : system performance analysis rating
SPS : standard positioning service, C/A code
SSALF : simplified short approach light system; sequenced flashing lights
SSALR : same as SSALF; runway alignment indicator lights
SSV : standard service volume
STAR : standard terminal arrival route
STC : sensitivity time control
STOL : short takeoff and landing

TACAN : tactical air navigation
TAR : test analysis report
TCH : threshold crossing height
T-Class : terminal VOR, TACAN, or VORTAC
TCOM : terminal communications
TD : time difference
TDI : TACAN distance indicator
TDM : time division multiplex
TDR : touchdown reflector
TDZ : touchdown zone
TDZL : touchdown zone lights
TERPS : terminal instrument procedures
TH : threshold
TLS : Transponder Landing System
TOWP : take-off waypoint
T/R : transponder-radar (system)
TRACALS : traffic control and landing systems
TRACON : terminal radar approach control (FAA)
TRIAD : 3 Loran C stations of a specific chain
TRSB : time reference scanning beam
T-VASI : T (configuration)—visual approach slope indicator
TVOR : terminal VOR
TWEB : transcribed weather broadcast equipment

u	: micro
UDF	: ultra high frequency direction finder
UHF	: ultra high frequency
USA	: United States Army
USN	: United States Navy
USAF	: United States Air Force
USSFIM	: United States Standard Flight Inspection Manual
UTC	: universal coordinated time
v	: volt
var.	: variation
VASI	: visual approach slope indicator
VDF	: very high frequency direction finder
VDOP	: vertical dilution of precision
VDP	: visual descent point
VFR	: visual flight rules
VGSI	: visual glide slope indicator
VHF	: very high frequency
VLF	: very low frequency
VOR	: very high frequency omnidirectional range
VORDME	: very high frequency omnidirectional range, distance measuring equipment
VOT	: very high frequency omnidirectional range test
VP	: vertical polarization
V/STOL	: vertical/short takeoff and landing
VORTAC	: very high frequency omnidirectional range, tactal air navigation
W	: watt
W.	: West
WGS-84	: World Geodetic Survey of 1984
WPDE	: waypoint displacement error
WPT	: waypoint
xmtr	: transmitter
XTK	: receiver cross-track information
XTKER	: crosstrack error
Z	: zulu time (Greenwich mean time)

SECTION 302. FORMULAS

302.1 Introduction. The following formulas and methods of calculation are presented as a ready reference.

302.2 General. The following information is of a general nature, and use of it may be applicable to more than one facility.

a. Constants Used in this Order. Following is a list of constants used in this order. Others are unique to a particular formula and can be found in reference material concerning the subject.

Constant	Definition/Derivation
6076.1	feet per nautical mile
3600	seconds per hour
106	tan 1° (6076.1)
0.00943	$\frac{1}{\tan 1^\circ (6076.1)}$
0.0159	$\frac{6076.1}{(3600)(106)}$
0.592	$\frac{3600}{6076.1}$

b. Rounding. Measurements and calculations should be carried to one decimal place more than that required for tolerance application. Then apply the following criteria to round off a measurement.

Numbers 1 to 5 - round off to zero
Numbers 6 to 9 - round off to the next higher value.

Example: Glidepath Course Width:

$0.755^\circ = 0.75^\circ$ and
$0.756^\circ = 0.76^\circ$

Exception: When a value exceeds a tolerance, it should not be rounded off to an in-tolerance condition.

Example: Glidepath Course Width:

= 0.903° is out of tolerance.

c. Time Average

$$T_{av} = \frac{2(T_1 \times T_2)}{(T_1 + T_2)}$$

Where:

T_{av} = Time average
T_1 = Time to cross in one direction
T_2 = Time to cross in opposite direction

d. Conversion of Knots to Feet per Second

$$V = \frac{6076.1 \times V_k}{3600}$$

Where:
V = Velocity (ft per sec)
V_k = Velocity (knots)

e. Slant Angle

$$\angle = \arctan \frac{A}{D}$$

Where:
A = Altitude above the horizontal (ft)
D = Geodetic distance (ft)
$\angle$ = Slant Angle (degrees)

f. Slant Range to Chart Distance

$$S = \frac{D}{\cos \angle}$$

Where:
D = Geodetic distance (ft)
S = Slant range distance (ft)
$\angle$ = Slant Angle (degrees)

g. Chart Distance to Slant Range

$$D = S \cos \angle$$

Where:
D = Geodetic distance (ft)
S = Slant range distance (ft)
$\angle$ = Slant angle (degrees)

h. Radio Line of Site

$$RLOS = 1.23\ (\sqrt{H_r} + \sqrt{H_t})$$

Where:
D = Distance (nm)
Hr = Height of receiving antenna (ft)
Ht = Height of transmitting antenna (ft)

I. Earth Curvature

$$Ec = (D)^2(0.883)$$

Where:
Ec = Earth Curvature (ft)
D = Distance from a point (nm)

302.3 VOR or TACAN

Modulation Percentage 135 and 15 Hz

$$15\text{ Hz modulation} = \frac{(V_1 + V_2) - (V_3 + V_4)}{(V_1 + V_2) + (V_3 + V_4)}$$

$$135\text{ Hz modulation} = \frac{(V_1 + V_3) - (V_2 - V_4)}{(V_1 + V_2) + (V_3 + V_4)}$$

Where:
V_1 = Max of 135 Hz and 15 Hz
V_2 = Min of 135 Hz at max of 15 Hz
V_3 = Max of 135 Hz and 15 Hz at min 15 Hz
V_4 = Min 135 and 15 Hz at min 15 Hz

302.4 Markers (75 MHz)

Marker Width

$$W_{ft} = \frac{(TAS)(T_{av})}{0{,}592} \quad \text{or}$$

$$W_{ft} = \frac{(G_s)(T)}{0.592} \quad \text{or}$$

$$W_{nm} = \frac{(TAS)(T_{av})}{3600}$$

Where:
G_s = Ground Speed (knots)
W_{ft} = Width (ft)
W_{nm} = Width (nm)
T = Time (sec)
TAS = True Airspeed (knots)
T_{av} = Time Average (sec)

302.5 Radar

Blind Speed using Non-Staggered or Uniform Pulse

$$V = \frac{291(PRF)}{F}$$

Where:
V = Groundspeed (knots)
PRF = Pulse Repetition Frequency (pulses/sec)
F = Transmitter Frequency (Mhz)

302.6 Localizer

a. Course Width

$$W = \frac{0.0159(ETAS)(T_{av})}{D}$$

Where:
W = Width (degrees)
ETAS = Effective True Airspeed (knots)
T_{av} = Time Average for course crossing (sec)
D = Distance from the localizer antenna to the point where the aircraft cross the localizer course (nm to the nearest thousandth)

Computed true airspeed (TAS) may be used if correction for crosswind component is applied from Figure 303-3.

b. Determining Localizer Tailored Width

$$W = 2\left(\arctan\left(\frac{350}{D}\right)\right)$$

Where:
W = Tailored Width (degrees)
D = Distance from the localizer antenna to the runway threshold (ft)

c. Dual Frequency Localizer Power Ratio

$$dB = 20 \log \frac{E_1}{E_2}$$

Where:
dB = Power ratio (dB)
E_1 = Signal Strength of course transmitter as read from the AGC Meter (μvolts)
E_2 = Signal Strength of clearance transmitter as read from the AGC Meter (μvolts)

302.7 Glide Slope

Glidepath Width or Angles

$$\theta = \arc\tan \frac{A}{D \pm F}$$

Where:
θ = Angle (degrees)
A = Absolute (Tapeline) altitude (ft) above the glide slope antenna
D = Geodetic distance (ft) from the glide slope antenna to the outer marker (or checkpoint)

$$F = 6076.1 \left(\frac{V}{3600}\right)T$$

NOTE: F is a factor. The value and sign (plus or minus) is determined by the location of the computation point on the recording.

- Assign a minus value to F if T occurs between the outer marker (or checkpoint) and the facility
- Assign a plus value to F if T occurs prior to the outer marker (or checkpoint)

V = Ground speed (knots)
T = Time to computation point (e.g., 75*u*A, 150HZ, 0*u*A, 75*u*A 90Hz for path width, and angle)

302.8 Precision Approach

Glidepath Angle

$$(1)\ \theta = \frac{A(0.00943)}{D}$$

Where:
θ = Glidepath Angle (degrees)
A = Absolute (Tapeline) altitude (ft) above the glide slope antenna
D = Distance from the Runway Point of Intercept (RPI) to the point where the glidepath is crossed (nm to the nearest thousandth)

$$(2)\ \theta = \frac{A(I_1)}{106(D)(I_2)}$$

Where:
θ = Glidepath Angle (degrees)
A = Absolute (Tapeline) altitude (ft) above the glide slope antenna
I_1 = Inches or units of recording paper from surveyed checkpoint to RPI
I_2 = Inches or units of recording paper from RPI to the point where the glidepath is crossed
D = Distance from the Runway Point of Intercept (RPI) to the point where the glidepath is crossed (nm to the nearest thousandth)

302.9 Procedures

Gradient and Climb Rates

$$\frac{Cfd}{60} : \frac{Gr}{1} : \frac{Cr}{Gs}$$

Where:
Cfd = Climb rate (ft/nm)
Gr = Gradient (in percent/100)
Cr = Rate of Climb (ft/min)
Gs = Ground Speed (knots)

This formula is expressed as a ratio which can be solved directly on a pilot's computer (e.g., Jeppson CR-3)

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302.9 Procedures

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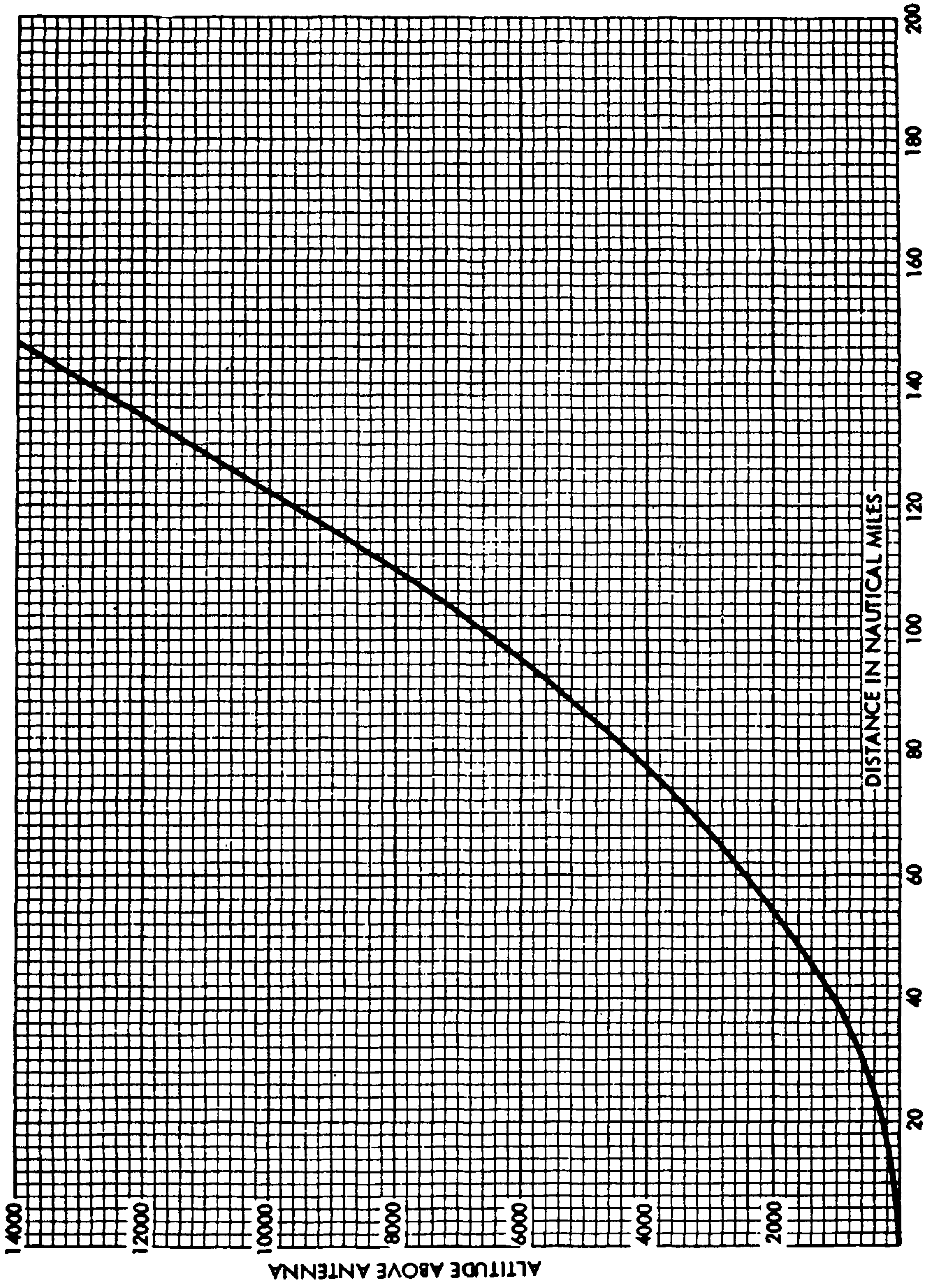
SECTION 303. WORKING GRAPHS AND CHARTS

RADIO LINE OF SIGHT CHART
Figure 303-1



CORRECTION FOR EARTH CURVATURE
Figure 303-2

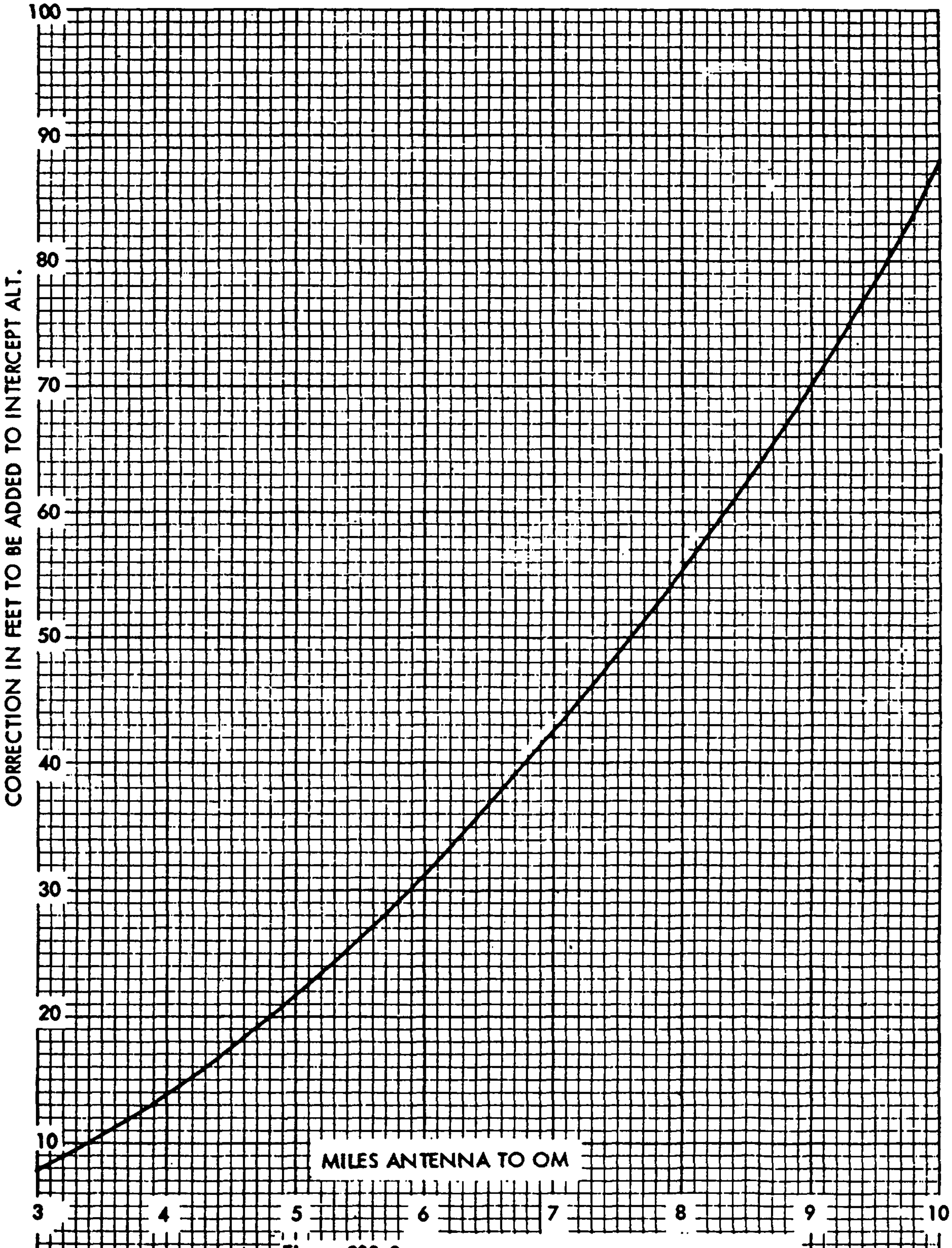
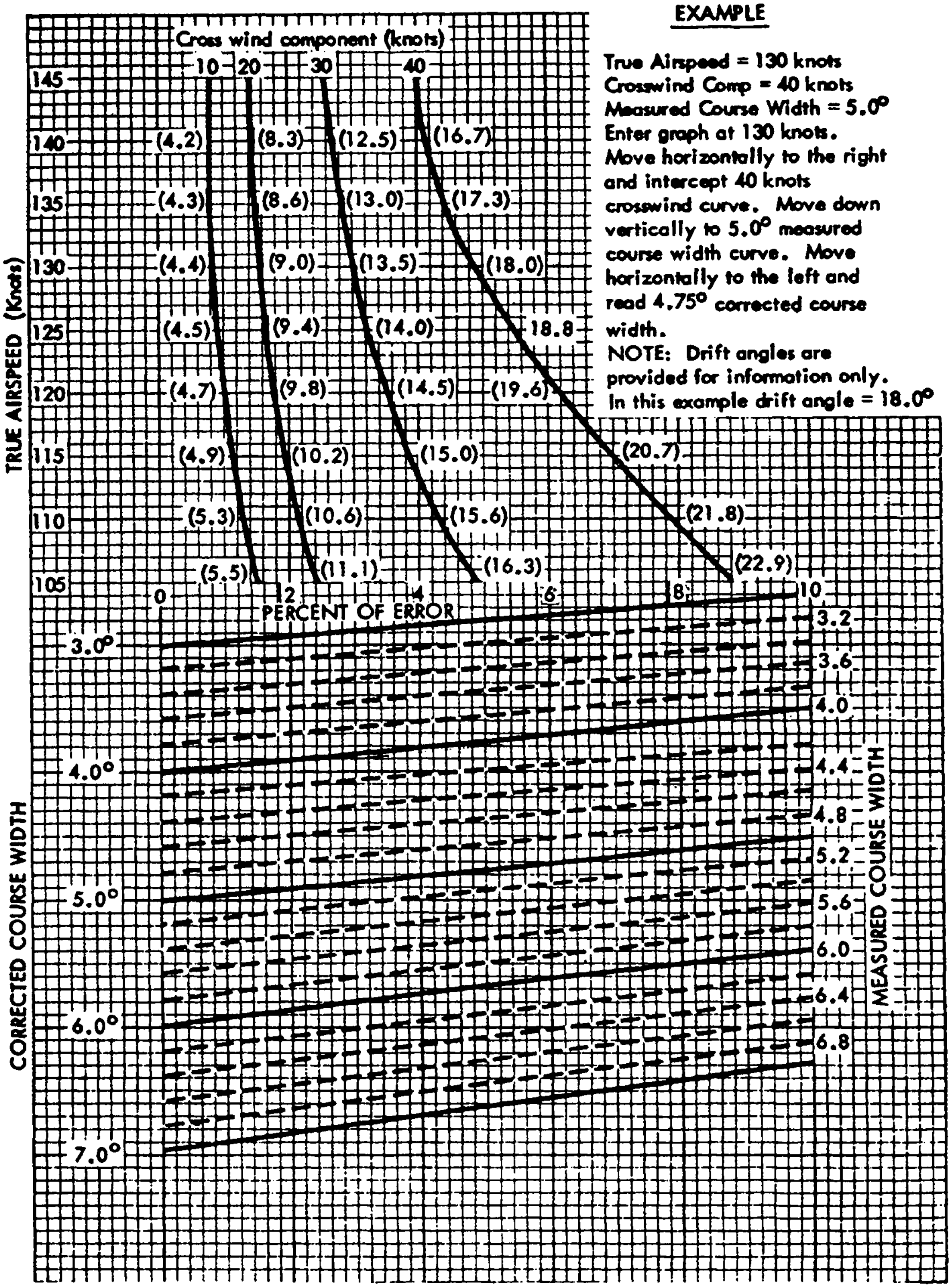


Figure 303-2 CORRECTION FOR EARTH CURVATURE

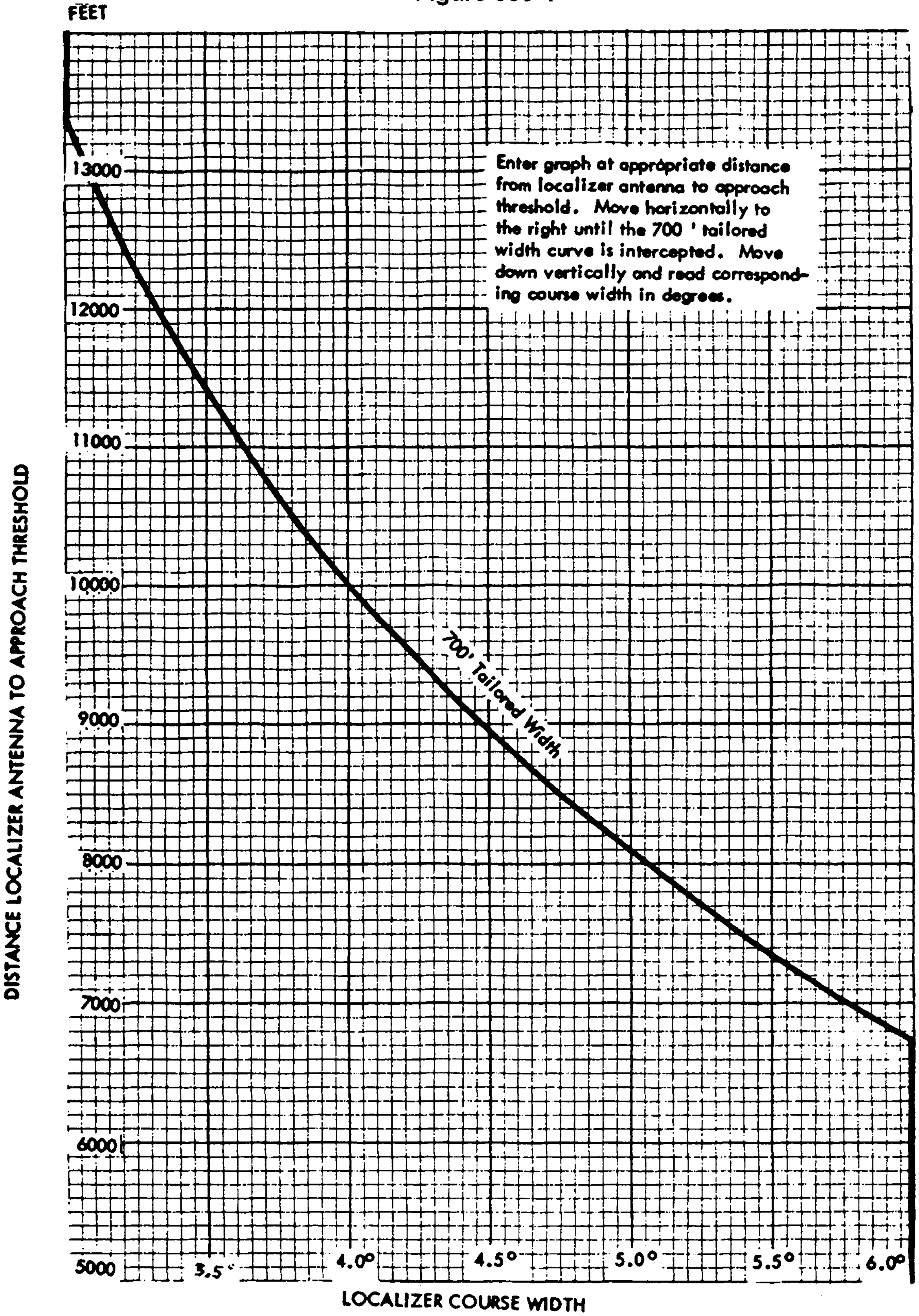
CORRECTED LOCALIZER COURSE WIDTH DUE TO CROSSWIND COMPONENT
Figure 303-3



EXAMPLE

True Airspeed = 130 knots
Crosswind Comp = 40 knots
Measured Course Width = 5.0°
Enter graph at 130 knots. Move horizontally to the right and intercept 40 knots crosswind curve. Move down vertically to 5.0° measured course width curve. Move horizontally to the left and read 4.75° corrected course width.
NOTE: Drift angles are provided for information only. In this example drift angle = 18.0°

TAILORED LOCALIZER COURSE WIDTH
Figure 303-4



ILS STRUCTURE TOLERANCES
Figure 303-5A

LOCALIZER

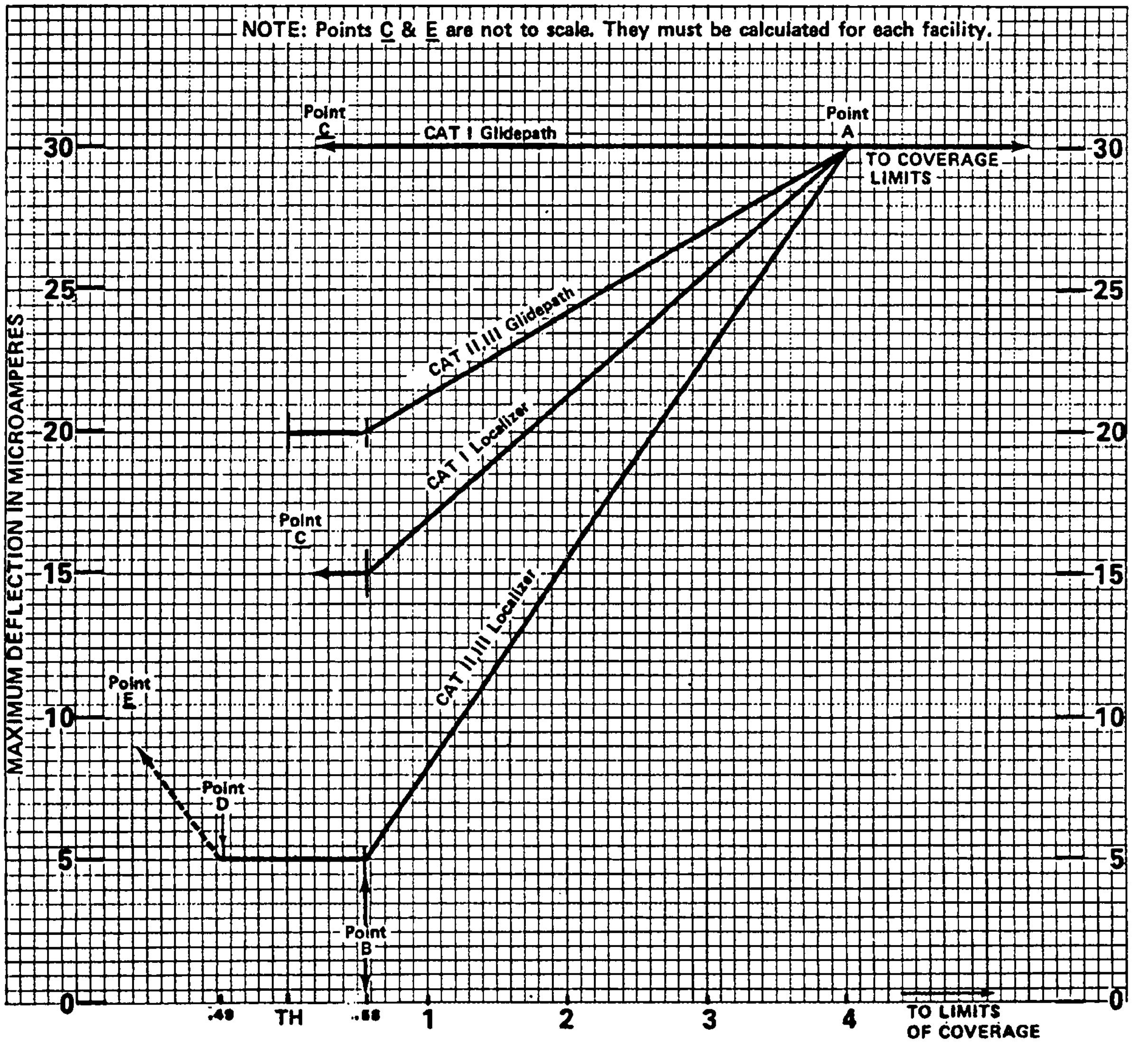
CAT I — Coverage Limits to PtA = 30 uA
Pt. A to Pt. B = 15 uA + (D-0.58) 4.39
Pt. B to Pt. C = 15 uA

CAT II, III — Coverage Limits to Pt. A = 30 uA
Pt. A to Pt. B = 5 uA + (D-0.58) 7.31
Pt. B to Pt. D = 5 uA
Pt. D to Pt. E = 5 uA + $(\frac{t}{T} 5)$

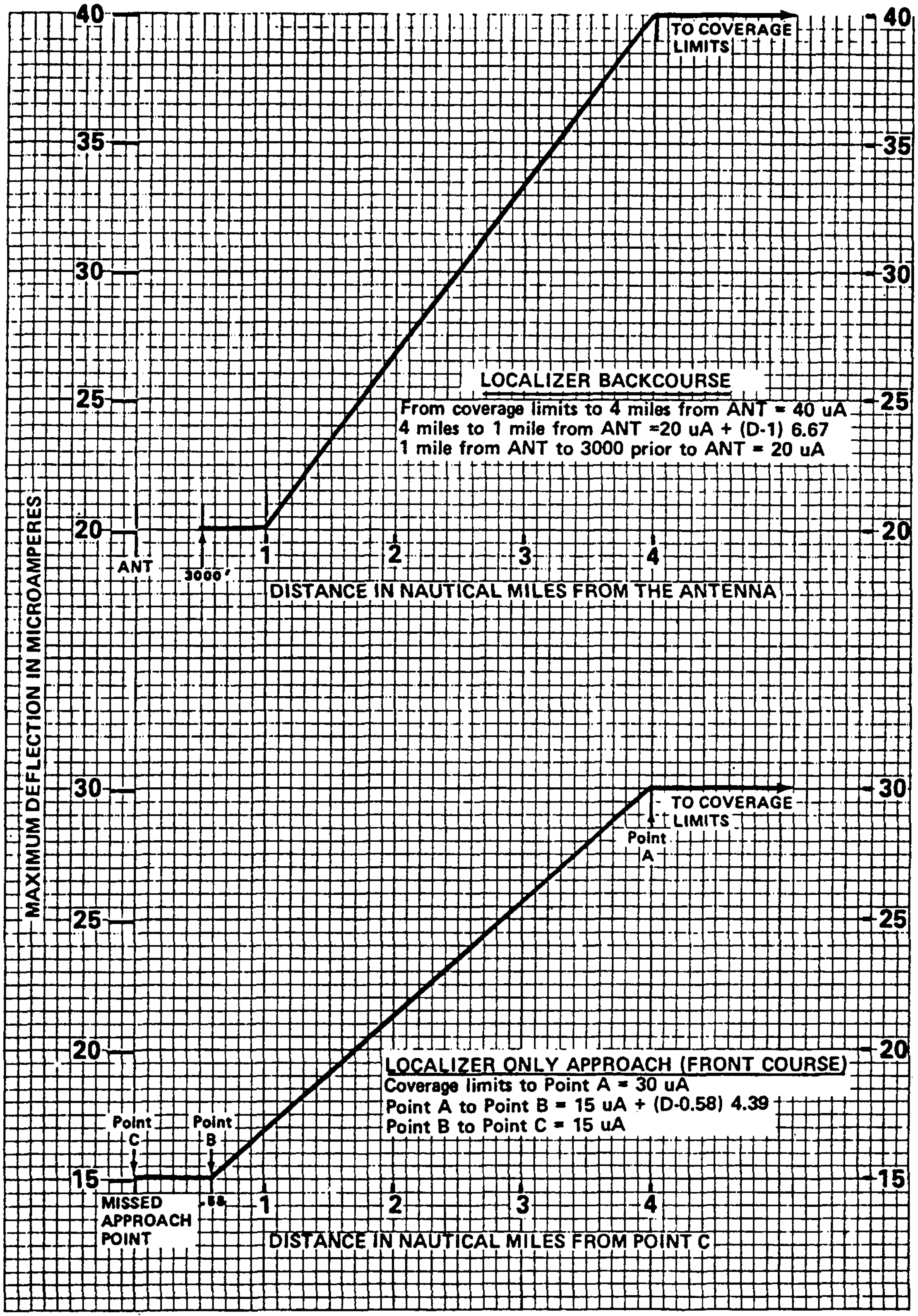
GLIDESLOPE

CAT I — Coverage Limits to Pt. C = 30 uA
CAT II, III — Coverage Limits to Pt. A = 30 uA
Pt. A to Pt. B = 20 uA + (D-0.58) 2.92
Pt. B to Threshold = 20 uA

D = Distance in nautical miles.
T = Distance in feet between Pt. D and Pt. E.
t = Distance in feet between Pt. D and the point at which the tolerance is being computed.

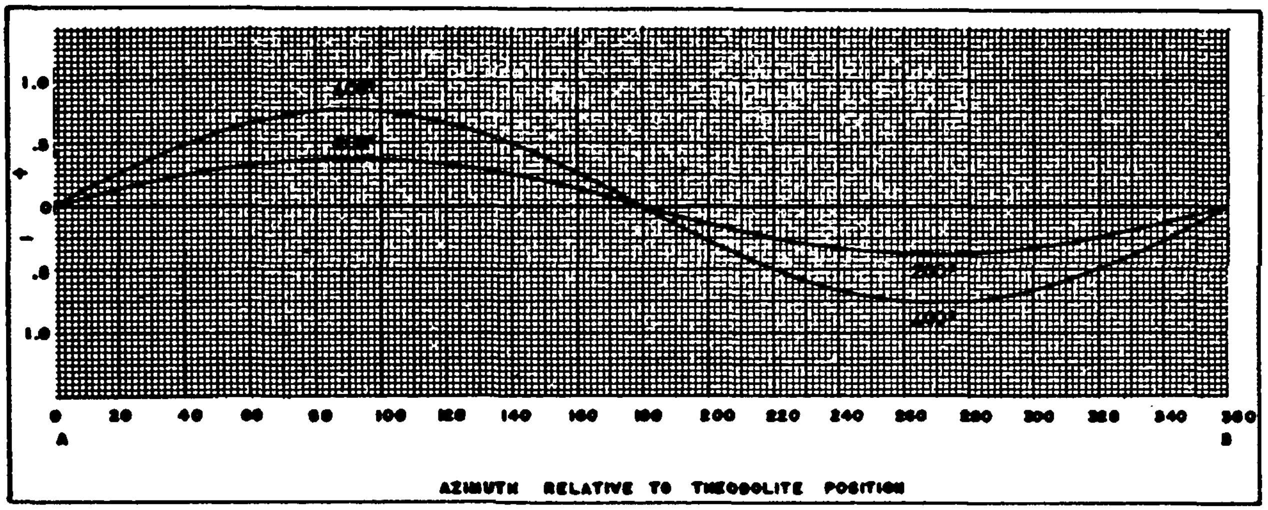


BACK COURSE AND LOCALIZER ONLY STRUCTURE TOLERANCES
Figure 303-5B



SECTION 304. THEODOLITE ERROR

APARENT ERROR CAUSED BY THEODOLITE POSITION
Figure 304



Five-mile Orbit. For 10-mile Orbit, use 1/2 the indicated error. Distance of theodolite from antenna: 200 ft. -- 400 ft. as marked. Azimuth may be read directly when theodolite is North of station (0^0). For other positions, enter the actual azimuth of the theodolite at Point A, and continue in sequence through 360^0 to Point B.

SECTION 305. FREQUENCY SPECTRUM

305.1 Frequency Allocation.

The following is a tabulation of frequencies available for use in the aeronautical, broadcast, and mobile bands. This tabulation may be used as an aid for identifying potential sources of interference. Also included is the VHF/UHF NAVAID Frequency Channeling and Pairing Chart which covers the X and Y channels for TACAN, 50 kHz spacing for VOR and LOC, and 150 kHz GS spacing. The Frequency Management Office can provide additional information regarding users of specific frequencies or bands of frequencies.

Frequency	Service
10 - 14 kHz	Omega
70 - 130 kHz	Decca-Dectra
192 and 194 kHz	Consolan (Shared with point-to-point communications).
200-415 kHz	L/MF radio beacons, ranges, and tower voice (285-325 kHz and 405-415 kHz shared with maritime navigational aids).
1605 kHz-24 mHz	MF/HF Communications (shared with all services and Goverment/non-Goverment users).
90 -110 kHz	Loran-C
75m Hz	VHF Marker Beacons
108-118 mHz	ILS Localizer & VOR
118-136 mHz	VHF Communications
162-174 mHz	Relay/Control of VORTAC
225-328.6 mHz	UHFCommunications
328.6-335.4 mHz	ILS Glide Slope
335.4-400 mHz	UHF Communications
406-420 mHz	Relay/Control of VORTAC
420-460 mHz	Radio Altimeter
960-1215 mHz	TACAN and DME
1030 mHz and 1090 mHz	ATC Radar Beacon
1215-1400 mHz	Long Range Surveillance Radar
1435-1535 mHz	Aeronautical Telemetering (Flight Tests)
1535-1542.5 mHz	Maritime Mobile-Satellite
1542.5-1543.5 mHz	Aeronautical Mobile-Satellite (R) and Maritime Mobile-Satellite

Frequency	Service
1543.5-1558.5 mHz	Aeronautical Mobile-Satellite (R)
1558.5-1636.5 mHz	Aeronautical Radio Navigation
1636.5-1644 mHz	Maritime Mobile-Satellite
1644-1645 mHz	Aeronautical Mobile-Satellite (R) and Maritime Mobile Satellite
1645-1660 mHz	Aeronautical Mobile Satellite (R)
2700-2900 mHz	Airport Surveillance Radar (shared with meteorological radar).
4200-4400 mHz	Radar Altimeter
5000-5250 mHz	Reserved for Aeronautical Radio Navigation and Space Radio Communication
5350-5470 mHz	Airborne Weather Radar
7125-8400 mHz	Microwave Link for Long Range Radar Relay
8800 mHz	Airborne Doppler Radar
9000-9200 mHz	Precision Approach Radar (PAR)
9300-9500 mHz	Airborne Weather Radar
13.25-13.4 gHz	Doppler Navigaton Aids
15.4-15.7 gHz	Reserved for Aeronautical Radio Navigation and Space Radio Communications
24.25-24.47 gHz	Airport Surface Detech Radar (ASDE)

Frequency	Broadcast
540-1600 kHz	Standard USA
2300-2495 kHz	Tropical Zone only
2500 kHz	WWV Standard Frequency
3200-3400 kHz	Tropical Zone only
3900-4000 kHz	International (Region 3 only)
3950-4000 kHz	International (Region 1 only)
4750-4995 kHz	Tropical Zone only
5000 kHz	WWV Standard Frequency
5005-5060 kHz	Tropical Zone only
5950-6200 kHz	International
9500-9775 kHz	International
10 mHz	WWV Standard Frequency
11.7-11.975 mHz	International
15 mHz	WWV Standard Frequency
15.1-15.45 mHz	International
17.7-17.9 mHz	International
20 mHz	WWV Standard Frequency
21.45-21.75 mHz	International
25 mHz	WWV Standard Frequency
25.6-26.1 mHz	International
54-72 mHz	Television, VHF
76-88 mHz	Television, VHF
88-108 mHz	FM
174-216 mHz	Television, VHF
470-890 mHz	Television, UHF

305.2 NOMENCLATURE OF FREQUENCY BANDS

305.21 International

VLF —Very Low Frequency—0-30 kHz

LF —Low Frequency—30-300 kHz

MF —Medium Frequency—300-3,000 kHz

HF —High Frequency—3,000-30,000 kHz

VHF—Very High Frequency—30,000 kHz-300 mHz

UHF—Ultra High Frequency—300-3,000 mHz

SHF—Super High Frequency—3,000-30,000 mHz

EHF—Extremely High Frequency—30,000-300,000 mHz

305.22 VHF/UHF NAVAID FREQUENCY CHANNELING AND PAIRING

						DME AIRBORNE INTERROGATE				DME GND REPLY	
						PULSE CODE					
DME					MLS	NORMAL		P/DME			
CHN	FREQUENCY				CHN	DME		IA	FA	DME	PC
NO.	LOC	GS	VOR	MLS	NO.	FREQ	us	us	us	FREQ	us
1X	-	-	-	-	-	1025	12	--	--	962	12
1Y	-	-	-	-	-	1025	36	--	--	1088	30
2X	-	-	-	-	-	1026	12	--	--	963	12
2Y	-	-	-	-	-	1026	36	--	--	1089	30
3X	-	-	-	-	-	1027	12	--	--	964	12
3Y	-	-	-	-	-	1027	36	--	--	1090	30
4X	-	-	-	-	-	1028	12	--	--	965	12
4Y	-	-	-	-	-	1028	36	--	--	1091	30
5X	-	-	-	-	-	1029	12	--	--	966	12
5Y	-	-	-	-	-	1029	36	-	-	1092	30
6X	-	-	-	-	-	1030	12	-	-	967	12
6Y	-	-	-	-	-	1030	36	-	-	1093	30
7X	-	-	-	-	-	1031	12	-	-	968	12
7Y	-	-	-	-	-	1031	36	-	-	1094	30
8X	-	-	-	-	-	1032	12	-	-	969	12
8Y	-	-	-	-	-	1032	36	-	-	1095	30
9X	-	-	-	-	-	1033	12	-	-	970	12
9Y	-	-	-	-	-	1033	36	-	-	1096	30
10X	-	-	-	-	-	1034	12	-	-	971	12
10Y	-	-	-	-	-	1034	36	-	-	1097	30
11X	-	-	-	-	-	1035	12	-	-	972	12
11Y	-	-	-	-	-	1035	36	-	-	1098	30
12X	-	-	-	-	-	1036	12	-	-	973	12
12Y	-	-	-	-	-	1036	36	-	-	1099	30
13X	-	-	-	-	-	1037	12	-	-	974	12
13Y	-	-	-	-	-	1037	36	-	-	1100	30
14X	-	-	-	-	-	1038	12	-	-	975	12
14Y	-	-	-	-	-	1038	36	-	-	1101	30
15X	-	-	-	-	-	1039	12	-	-	976	12
15Y	-	-	-	-	-	1039	36	-	-	1102	30
16X	-	-	-	-	-	1040	12	-	-	977	12
16Y	-	-	-	-	-	1040	36	-	-	1103	30
17X	-	-	108.00	-	-	1041	12	-	-	978	12
17Y	-	-	108.05	5043.0	540	1041	36	36	42	1104	30
18X	108.10	334.70	-	5031.0	500	1042	12	12	18	979	12
18Y	108.15	334.55	-	5043.6	542	1042	36	36	42	1105	30
19X	-	-	108.20	-	-	1043	12	-	-	980	12
19Y	-	-	108.25	-	-	1043	36	36	42	1106	30

VHF/UHF NAVAID FREQUENCY CHANNELING AND PAIRING, CONTINUED

DME CHN NO.	FREQUENCY LOC	FREQUENCY GS	FREQUENCY VOR	FREQUENCY MLS	MLS CHN NO.	DME AIRBORNE INTERROGATE PULSE CODE NORMAL DME FREQ	NORMAL us	P/DME IA us	P/DME FA us	DME GND REPLY DME FREQ	DME GND REPLY PC us
20X	108.30	334.10	-	5031.6	502	1044	12	12	18	981	12
20Y	108.35	333.95	-	5044.8	546	1044	36	36	42	1107	30
21X	-	-	108.40	-	-	1045	12	-	-	982	12
21Y	-	-	108.45	5045.4	548	1045	36	36	42	1108	30
22X	108.50	329.90	-	5032.2	504	046	12	12	18	983	12
22Y	108.55	329.75	-	5046.0	550	1046	36	36	42	1109	30
23X	-	-	108.60	-	-	1047	12	-	-	984	12
23Y	-	-	108.65	5046.6	552	1047	36	36	42	1110	30
24X	108.70	330.50	-	5032.8	506	1048	12	12	18	985	12
24Y	108.75	330.35	-	5047.2	554	1048	36	36	42	1111	30
25X	-	-	108.80	-	-	1049	12	-	-	986	12
25Y	-	-	108.85	5047.8	556	1049	36	36	42	1112	30
26X	108.90	329.30	-	5033.4	508	1050	12	12	18	987	12
26Y	108.95	329.15	-	5048.4	558	1050	36	36	42	1113	30
27X	-	-	109.00	-	-	1051	12	-	-	988	12
27Y	-	-	109.05	5049.0	560	1051	36	36	42	1114	30
28X	109.10	331.40	-	5034.0	510	1052	12	12	18	989	12
28Y	109.15	331.25	-	5049.6	562	1052	36	36	42	1115	30
29X	-	-	109.20	-	-	1053	12	-	-	990	12
29Y	-	-	109.25	5050.2	564	1053	36	36	42	1116	30
30X	109.30	332.00	-	5034.6	512	1054	12	12	18	991	12
30Y	109.35	331.85	-	5050.8	566	1054	36	36	42	1117	30
31X	-	-	109.40	-	-	1055	12	-	-	992	12
31Y	-	-	109.45	5051.4	568	1055	36	36	42	1118	30
32X	109.50	332.60	-	5035.2	514	1056	12	12	18	993	12
32Y	109.55	332.45	-	5052.0	570	1056	36	36	42	1119	30
33X	-	-	109.60	-	-	1057	12	-	-	994	12
33Y	-	-	109.65	5052.6	572	1057	36	36	42	1120	30
34X	109.70	333.20	-	5035.8	516	1058	12	12	18	995	12
34Y	109.75	333.05	-	5053.2	574	1058	36	36	42	1121	30
35X	-	-	109.80	-	-	1059	12	-	-	996	12
35Y	-	-	109.85	5053.8	576	1059	36	36	42	1122	30
36X	109.90	333.80	-	5036.4	518	1060	12	12	18	997	12
36Y	109.95	333.65	-	5054.4	578	1060	36	36	42	1123	30
37X	-	-	110.00	-	-	1061	12	-	-	998	12
37Y	-	-	110.05	5055.0	580	1061	36	36	42	1124	30
38X	110.10	334.40	-	5037.0	520	1062	12	12	18	999	12
38Y	110.15	334.25	-	5055.6	582	1062	36	36	42	1125	30
39X	-	-	111.20	-	-	1063	12	-	-	1000	12
39Y	-	-	111.25	5056.2	584	1063	36	36	42	1126	30
40X	110.30	335.00	-	5037.6	522	1064	12	12	18	1001	12
40Y	110.35	334.85	-	5056.8	586	1064	36	36	42	1127	30
41X	-	-	111.40	-	-	1065	12	-	-	1002	12
41Y	-	-	111.45	5057.4	588	1065	36	36	42	1128	30

VHF/UHF NAVAID FREQUENCY CHANNELING AND PAIRING, CONTINUED

DME CHN NO.	FREQUENCY LOC	FREQUENCY GS	FREQUENCY VOR	FREQUENCY MLS	MLS CHN NO.	DME AIRBORNE INTERROGATE PULSE CODE NORMAL DME FREQ	NORMAL us	P/DME IA us	P/DME FA us	DME GND REPLY DME FREQ	PC us
42X	110.50	329.60	-	5038.2	524	1066	12	12	18	1003	12
42Y	110.55	329.45	-	5058.0	590	1066	36	36	42	1129	30
43X	-	-	111.60	-	-	1067	12	-	-	1004	12
43Y	-	-	111.65	5058.6	592	1067	36	36	42	1130	30
44X	110.70	330.20	-	5038.8	526	1068	12	12	18	1005	12
44Y	110.75	330.05	-	5059.2	594	1068	36	36	42	1131	30
45X	-	-	110.80	-	-	1069	12	-	-	1006	12
45Y	-	-	110.85	5059.8	596	1069	36	36	42	1132	30
46X	110.90	330.80	-	5039.4	528	1070	12	12	18	1007	12
46Y	110.95	330.65	-	5060.4	598	1070	36	36	42	1133	30
47X	-	-	110.00	-	-	1071	12	-	-	1008	12
47Y	-	-	110.05	5061.0	600	1071	36	36	42	1134	30
48X	111.10	331.70	-	5040.0	530	1072	12	12	18	1009	12
48Y	111.15	331.55	-	5061.6	602	1072	36	36	42	1135	30
49X	-	-	111.20	-	-	1073	12	-	-	1010	12
49Y	-	-	111.25	5062.2	604	1073	36	36	42	1136	30
50X	111.30	332.30	-	5040.6	532	1074	12	12	18	1011	12
50Y	111.35	332.15	-	5062.8	606	1074	36	36	42	1137	30
51X	-	-	111.40	-	-	1075	12	-	-	1012	12
51Y	-	-	111.45	5063.4	608	1075	36	36	42	1138	30
52X	111.50	332.90	-	5041.2	534	1076	12	12	18	1013	12
52Y	111.55	332.75	-	5064.0	610	1076	36	36	42	1139	30
53X	-	-	111.60	-	-	1077	12	-	-	1014	12
53Y	-	-	111.65	5064.6	612	1077	36	36	42	1140	30
54X	111.70	333.50	-	5041.8	536	1078	12	12	18	1015	12
54Y	111.75	333.35	-	5065.2	614	1078	36	36	42	1141	30
55X	-	-	111.80	-	-	1079	12	-	-	1016	12
55Y	-	-	111.85	5065.8	616	1079	36	36	42	1142	30
56X	111.90	331.10	-	5042.4	538	1080	12	12	18	1017	12
56Y	111.95	330.95	-	5066.4	618	1080	36	36	42	1143	30
57X	-	-	112.00	-	-	1081	12	-	-	1018	12
57Y	-	-	112.05	-	-	1081	36	-	-	1144	30
58X	-	-	112.10	-	-	1082	12	-	-	1019	12
58Y	-	-	112.15	-	-	1082	36	-	-	1145	30
59X	-	-	112.20	-	-	1083	12	-	-	1020	12
59Y	-	-	112.25	-	-	1083	36	-	-	1146	30
60X	-	-	-	-	-	1084	12	-	-	1021	12
60Y	-	-	-	-	-	1084	36	-	-	1147	30
61X	-	-	-	-	-	1085	12	-	-	1022	12
61Y	-	-	-	-	-	1085	36	-	-	1148	30
62X	-	-	-	-	-	1086	12	-	-	1023	12
62Y	-	-	-	-	-	1086	36	-	-	1149	30
63X	-	-	-	-	-	1087	12	-	-	1024	12
63Y	-	-	-	-	-	1087	36	-	-	1150	30

VHF/UHF NAVAID FREQUENCY CHANNELING AND PAIRING, CONTINUED

DME CHN NO.	FREQUENCY LOC	FREQUENCY GS	FREQUENCY VOR	FREQUENCY MLS	MLS CHN NO.	DME AIRBORNE INTERROGATE PULSE CODE NORMAL DME FREQ	NORMAL us	P/DME IA us	P/DME FA us	DME GND REPLY DME FREQ	PC us
64X	-	-	-	-	-	1088	12	-	-	1151	12
64Y	-	-	-	-	-	1088	36	-	-	1025	30
65X	-	-	-	-	-	1089	12	-	-	1152	12
65Y	-	-	-	-	-	1089	36	-	-	1026	30
66X	-	-	-	-	-	1090	12	-	-	1153	12
66Y	-	-	-	-	-	1090	36	-	-	1027	30
67X	-	-	-	-	-	1091	12	-	-	1154	12
67Y	-	-	-	-	-	1091	36	-	-	1028	30
68X	-	-	-	-	-	1092	12	-	-	1155	12
68Y	-	-	-	-	-	1092	36	-	-	1029	30
69X	-	-	-	-	-	1093	12	-	-	1156	12
69Y	-	-	-	-	-	1093	36	-	-	1030	30
70X	-	-	112.30	-	-	1094	12	-	-	1157	12
70Y	-	-	112.35	-	-	1094	36	-	-	1031	30
71X	-	-	112.40	-	-	1095	12	-	-	1158	12
71Y	-	-	112.45	-	-	1095	36	-	-	1032	30
72X	-	-	112.50	-	-	1096	12	-	-	1159	12
72Y	-	-	112.55	-	-	1096	36	-	-	1033	30
73X	-	-	112.60	-	-	1097	12	-	-	1160	12
73Y	-	-	112.65	-	-	1097	36	-	-	1034	30
74X	-	-	112.70	-	-	1098	12	-	-	1161	12
74Y	-	-	112.75	-	-	1098	36	-	-	1035	30
75X	-	-	112.80	-	-	1099	12	-	-	1162	12
75Y	-	-	112.85	-	-	1099	36	-	-	1036	30
76X	-	-	112.90	-	-	1100	12	-	-	1163	12
76Y	-	-	112.95	-	-	1100	36	-	-	1037	30
77X	-	-	113.00	-	-	1101	12	-	-	1164	12
77Y	-	-	113.05	-	-	1101	36	-	-	1038	30
78X	-	-	113.10	-	-	1102	12	-	-	1165	12
78Y	-	-	113.15	-	-	1102	36	-	-	1039	30
79X	-	-	113.20	-	-	1103	12	-	-	1166	12
79Y	-	-	113.25	-	-	1103	36	-	-	1040	30
80X	-	-	113.30	-	-	1104	12	-	-	1167	12
80Y	-	-	113.35	5067.0	620	1104	36	36	42	1041	30
81X	-	-	113.40	-	-	1105	12	-	-	1168	12
81Y	-	-	113.45	5067.6	622	1105	36	36	42	1042	30
82X	-	-	113.50	-	-	1106	12	-	-	1169	12
82Y	-	-	113.55	5068.2	624	1106	36	36	42	1043	30
83X	-	-	113.60	-	-	1107	12	-	-	1170	12
83Y	-	-	113.65	5068.8	626	1107	36	36	42	1044	30
84X	-	-	113.70	-	-	1108	12	-	-	1171	12
84Y	-	-	113.75	5069.4	628	1108	36	36	42	1045	30
85X	-	-	113.80	-	-	1109	12	-	-	1172	12
85Y	-	-	113.85	5070.0	630	1109	36	36	42	1046	30

VHF/UHF NAVAID FREQUENCY CHANNELING AND PAIRING, CONTINUED

DME CHN NO.	FREQUENCY LOC	FREQUENCY GS	FREQUENCY VOR	FREQUENCY MLS	MLS CHN NO.	DME AIRBORNE INTERROGATE DME FREQ	PULSE CODE NORMAL us	PULSE CODE P/DME IA us	PULSE CODE P/DME FA us	DME GND REPLY DME FREQ	DME GND REPLY PC us
86X	-	-	113.90	-	-	1110	12	-	-	1173	12
86Y	-	-	113.95	5070.6	632	1110	36	36	42	1047	30
87X	-	-	114.00	-	-	1111	12	-	-	1174	12
87Y	-	-	114.05	5071.2	634	1111	36	36	42	1048	30
88X	-	-	114.10	-	-	1112	12	-	-	1175	12
88Y	-	-	114.15	5071.8	636	1112	36	36	42	1049	30
89X	-	-	114.20	-	-	1113	12	-	-	1176	12
89Y	-	-	114.25	5072.4	638	1113	36	36	42	1050	30
90X	-	-	114.30	-	-	1114	12	-	-	1177	12
90Y	-	-	114.35	5073.0	640	1114	36	36	42	1051	30
91X	-	-	114.40	-	-	1115	12	-	-	1178	12
91Y	-	-	114.45	5073.6	642	1115	36	36	42	1052	30
92X	-	-	114.50	-	-	1116	12	-	-	1179	12
92Y	-	-	114.55	5074.2	644	1116	36	36	42	1053	30
93X	-	-	114.60	-	-	1117	12	-	-	1180	12
93Y	-	-	114.65	5074.8	646	1117	36	36	42	1054	30
94X	-	-	114.70	-	-	1118	12	-	-	1181	12
94Y	-	-	114.75	5075.4	648	1118	36	36	42	1055	30
95X	-	-	114.80	-	-	1119	12	-	-	1182	12
95Y	-	-	114.85	5076.0	650	1119	36	36	42	1056	30
96X	-	-	114.90	-	-	1120	12	-	-	1183	12
96Y	-	-	114.95	5076.6	652	1120	36	36	42	1057	30
97X	-	-	115.00	-	-	1121	12	-	-	1184	12
97Y	-	-	115.05	5077.2	654	1121	36	36	42	1058	30
98X	-	-	115.10	-	-	1122	12	-	-	1185	12
98Y	-	-	115.15	5077.8	656	1122	36	36	42	1059	30
99X	-	-	115.20	-	-	1123	12	-	-	1186	12
99Y	-	-	115.25	5078 4	658	1123	36	36	42	1060	30
100X	-	-	115.30	-	-	1124	12	-	-	1187	12
100Y	-	-	115.35	5079.0	660	1124	36	36	42	1061	30
101X	-	-	115.40	-	-	1125	12	-	-	1188	12
101Y	-	-	115.45	5079.6	662	1125	36	36	42	1062	30
102X	-	-	115.50	-	-	1126	12	-	-	1189	12
102Y	-	-	115.55	5050.2	664	1126	36	36	42	1063	30
103X	-	-	115.60	-	-	1127	12	-	-	1190	12
103Y	-	-	115.65	5080.8	666	1127	36	36	42	1064	30
104X	-	-	115.70	-	-	1128	12	-	-	1191	12
104Y	-	-	115.75	5081.4	668	1128	36	36	42	1065	30
105X	-	-	115.80	-	-	1129	12	-	-	1192	12
105Y	-	-	115.85	5082.0	670	1129	36	36	42	1066	30
106X	-	-	115.90	-	-	1130	12	-	-	1193	12
106Y	-	-	115.95	5082.6	672	1130	36	36	42	1067	30
107X	-	-	116.00	-	-	1131	12	-	-	1194	12
107Y	-	-	116.05	5083.2	674	1131	36	36	42	1068	30

VHF/UHF NAVAID FREQUENCY CHANNELING AND PAIRING, CONTINUED

DME CHN NO.	FREQUENCY LOC	FREQUENCY GS	FREQUENCY VOR	FREQUENCY MLS	MLS CHN NO.	DME AIRBORNE INTERROGATE DME FREQ	PULSE CODE NORMAL DME us	PULSE CODE P/DME IA us	PULSE CODE P/DME FA us	DME GND REPLY DME FREQ	DME GND REPLY PC us
86X	-	-	113.90	-	-	1110	12	-	-	1173	12
86Y	-	-	113.95	5070.6	632	1110	36	36	42	1047	30
87X	-	-	114.00	-	-	1111	12	-	-	1174	12
87Y	-	-	114.05	5071.2	634	1111	36	36	42	1048	30
88X	-	-	114.10	-	-	1112	12	-	-	1175	12
88Y	-	-	114.15	5071.8	636	1112	36	36	42	1049	30
89X	-	-	114.20	-	-	1113	12	-	-	1176	12
89Y	-	-	114.25	5072.4	638	1113	36	36	42	1050	30
90X	-	-	114.30	-	-	1114	12	-	-	1177	12
90Y	-	-	114.35	5073.0	640	1114	36	36	42	1051	30
91X	-	-	114.40	-	-	1115	12	-	-	1178	12
91Y	-	-	114.45	5073.6	642	1115	36	36	42	1052	30
92X	-	-	114.50	-	-	1116	12	-	-	1179	12
92Y	-	-	114.55	5074.2	644	1116	36	36	42	1053	30
93X	-	-	114.60	-	-	1117	12	-	-	1180	12
93Y	-	-	114.65	5074.8	646	1117	36	36	42	1054	30
94X	-	-	114.70	-	-	1118	12	-	-	1181	12
94Y	-	-	114.75	5075.4	648	1118	36	36	42	1055	30
95X	-	-	114.80	-	-	1119	12	-	-	1182	12
95Y	-	-	114.85	5076.0	650	1119	36	36	42	1056	30
96X	-	-	114.90	-	-	1120	12	-	-	1183	12
96Y	-	-	114.95	5076.6	652	1120	36	36	42	1057	30
97X	-	-	115.00	-	-	1121	12	-	-	1184	12
97Y	-	-	115.05	5077.2	654	1121	36	36	42	1058	30
98X	-	-	115.10	-	-	1122	12	-	-	1185	12
98Y	-	-	115.15	5077.8	656	1122	36	36	42	1059	30
99X	-	-	115.20	-	-	1123	12	-	-	1186	12
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100X	-	-	115.30	-	-	1124	12	-	-	1187	12
100Y	-	-	115.35	5079.0	660	1124	36	36	42	1061	30
101X	-	-	115.40	-	-	1125	12	-	-	1188	12
101Y	-	-	115.45	5079.6	662	1125	36	36	42	1062	30
102X	-	-	115.50	-	-	1126	12	-	-	1189	12
102Y	-	-	115.55	5050.2	664	1126	36	36	42	1063	30
103X	-	-	115.60	-	-	1127	12	-	-	1190	12
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105Y	-	-	115.85	5082.0	670	1129	36	36	42	1066	30
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106Y	-	-	115.95	5082.6	672	1130	36	36	42	1067	30
107X	-	-	116.00	-	-	1131	12	-	-	1194	12
107Y	-	-	116.05	5083.2	674	1131	36	36	42	1068	30

SECTIONS 306 - 308

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SECTIONS 306 - 308

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SECTION 309. MAP INTERPRETATION

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Paragraphs	*Title*	*Pages*

SECTION 309. MAP INTERPRETATION

309.1 Introduction

a. Aeronautical charts normally used for checkpoint orbit checks have substantial effect on the data processing center. Through the cooperation of the United States Coast and Geodetic Survey, certain information concerning aeronautical charts has been collected. Coast and Geodetic Survey personnel have accompanied flight crews on orbit type checks. Outlined here is information considered helpful in improving the accuracy of flight inspection results, with particular reference to chart construction, design, and preparation for flight inspection use, checkpoint selection, etc.

b. The use of state highway maps or county maps is not recommended if aeronautical charts are available, as there is considerable variation in the accuracy of the maps among various states and counties.

c. It has been determined, however, that the **Defense Mapping Agency Series 1501, Joint Operations Graphics,** although not aeronautical charts, are satisfactory for flight inspection use. Due to the scale of these maps (1 to 250,000), greater detail is available than that displayed by the sectional charts; consequently more definable checkpoints can be utilized.

d. The positions of many facility sites have been determined by first-order triangulation or photogrammetric methods with a high degree of accuracy. Before recommending that coordinates of a facility be changed, the Coast and Geodetic Survey should be contacted for verification of such a change.

309.2 Aeronautical Chart Preparation

a. In congested areas of the Nation, checkpoints are plentiful, and it is possible to select only the most desirable. In sparsely settled areas, it may be necessary to use every feature appearing on the chart in order to obtain a maximum of 8 or 10 checkpoints. For these reasons, it is helpful to have an understanding of the manner in which final drawings for aeronautical charts are made.

b. The preparation of final drawings for charts using three separate colors is made as follows:

(1) Black. Includes railroads, roads (these are sketched in black, but photograph gray on final chart), city and town symbols, boundaries, dots showing the location of spot heights, landmark symbols, etc.

(2) Blue. Drainage.

(3) Brown. Contours.

c. The black is always drawn first and remaining colors are drawn only after the black has been verified and corrected.

d. In order to provide satisfactory clearances between various features, it is often necessary to shift some away from their correct geographic positions. This shift does not usually amount to more than 1/32 of an inch on the printed chart, but it is often required for increased clarity and legibility of the chart. In shifting, two general conditions are to be met:

(1) All possible detail in the relative position of the features is retained as closely as possible.

(2) The geographic position of the combination of features is retained as closely as possible.

e. For example, in case of a road paralleling a railroad for a short distance, the railroad is drawn in its true geographic position, and the road is displaced enough to provide the required clearance. If both were displaced by equal amounts, as first might be suspected, a curve that is nonexistent in fact would have to be introduced into the railroad or the railroad would have to be displaced for some little distance on either side, with consequent displacement of towns and other features along the railroad.

f. Similarly, if a road parallels the railroad for a short distance, then crosses and again parallels the railroad on the other side, the railroad should be shown in its correct position and the road displaced as before.

g. Further, there are conditions where a road may parallel a railroad for a short distance, and both may be displaced by an amount equal to one-half the required clearance.

h. In general, it has been found that a railroad should be held in its correct position first, a road second, and stream last. That is, between a railroad and a highway or stream, the latter are usually shifted; between a road and a stream, the stream is displaced.

i. If a stream flows between a road and a railroad, or between two railroads, *the stream retains its true position* and other features are displaced. As a rule, all town and city symbols are affixed in their correct positions. Since railroads and towns are usually held in their correct positions, other features are adjusted to them. Landmarks such as oil derricks, race-tracks, etc., should be used only as a last resort.

j. Since each color on a printed chart is a separate sheet, the registration of the colors may be checked at the "neat line" at each corner of the chart. The color which is not correct can be identified by the color tick. If a color is too far from correct registration, several charts should be examined and an effort made to obtain one that is more accurate.

309.3 Preparation of Charts for Flight Inspection Use. In preparing a chart for a flight inspection, the following procedure is outlined.

a. The *exact* latitude and longitude of the facility should be plotted on the chart as follows:

(1) Plot the longitude on parallels, which are subdivided into 1-minute intervals, north and south of the station, then draw a fine line connecting these two points and extend the line far enough in both directions to fit a large protractor. This will be the true north reference. The latitude should be scaled, using hairspring dividers, from the parallel below the site along the nearest meridian, subdivided into 1-minute - intervals, and then be transferred to the true north reference where it intersects the same parallel. Because of curvature in the parallels, this procedure will be far more accurate than measuring the latitude on each side of the site and then drawing a line between the two points of latitude.

(2) If two or more charts must be joined together, such as Kansas City and Des Moines for the St. Joseph VOR, it is suggested that the following method be used: Select one of the charts which will be used to plot the correct position of the VOR and use it as the overlay chart. For example, the correct position of the STJ VOR is to be plotted on the Kansas City chart. Place a straight edge on the intersection of north lat. $40^{o}05'00"$ and $94^{o}00'00"$ west long. Draw a *straight line* between these two points. The use of a razor blade for cutting along a straight edge is preferred. This chart will be mounted on the Des Moines chart by correctly aligning the central meridian of $95^{o}00'00"$ and placing the two points mentioned above in their correct position. The slight difference in the size of the two charts will fall away from the central meridian and allow the minimum error near the station. If it is necessary to join four charts together, it is suggested that the two north charts be mounted on the two south charts to form the east and west half, then the east and west sections may be mounted along a meridian such as $96^{o}00'00"$,making sure that the 40^{o} parallel is in correct alignment and that the 96th meridian is in a straight line.

(3) The magnetic north reference may not be plotted from the facility location with magnetic variation interpolated from the lines of magnetic variation shown on the chart. The determination of the correct magnetic variation is extremely important. Whenever possible, the magnetic variation should be obtained from the latest information available through the Coast and Geodetic Survey. If the available information is not up to date, the annual rate of change in variation should be applied. It is conceivable that errors as great as 0.5^{o} may occur if proper determination of magnetic variation is not made through use of the latest and most accurate source of this information.

(4) After the magnitude of magnetic variation has been determined, it is suggested that this be plotted on the chart using at least a 6-inch circular protractor and marking it from the true north reference, both north and south of the site and connecting the two points with a fine line which passes directly through the site. The 90^{o} to 270^{o} magnetic lines may be marked by resetting the protractor on the magnetic north reference.

309.4 Use of the Chart

a. In the selection of checkpoints, black should be used first, gray second, and blue (drainage) last. Only in rare cases will be the facility site be accurately located. Consequently, the facility location should always be plotted as outlined above.

b. One good checkpoint each 30^{o} provides more repeatable results (provided constant radius is maintained) than large numbers of checkpoints using all types of map information.

c. If the same chart is used over an extended period of time, it may be necessary to realign the magnetic north reference line due to annual change in the variation. This is particularly true in some areas where the annual rate of change is extraordinary.

SECTION 310. ESTIMATED ERROR CURVE

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SECTION 310. ESTIMATED ERROR CURVE

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SECTION 310. ESTIMATED ERROR CURVE

310.1 Introduction.

a. Procedures outlined herein have evolved over a period of years, and have been determined to be the simplest and most expeditious means of placing necessary analytical information in the hands of the flight inspector while he is still at the site, conducting the flight inspection.

b. It is recognized here, as the title of this section indicates, that information derived in this manner is an estimate only and is in no way to be construed as final. Detailed analysis of recordings will be conducted through a central agency as in the past.

c. This estimated error curve, however, may reasonably be assumed to have an accuracy within 0.5 degrees and can, therefore, be an invaluable aid in on-the-spot analysis of a given situation.

310.2 Preparation of Aeronautical Chart

a. Prepare a chart showing the exact plot of the station location. Plot the latitude and longitude, extending the lines (true) to 60 miles. The compass rose as printed on the chart should not be used because such overlay plots are often inaccurate. A plotting error of 1/16 inch at this point results in an error of 1.4 degrees in the bearing of a checkpoint 20 miles away. The magnetic variation to the nearest 15 seconds is plotted, and the magnetic north, south, east, and west lines are extended to 60 miles, using black ink.

b. With the station as center, circles with radii of 5, 20, 30, 40, and 50 miles are drawn in black ink. Distances may be varied slightly for these radii to accommodate the maximum number of checkpoints.

c. Airway radials are also drawn on the chart using black ink. These radial lines should be broken approximately 1 mile either side of the circles to prevent obscuring the map on the orbit tracks.

d. The map is cut around the circumference, which permits it to fit the azimuth plotting board. The chart center is reinforced, front and back, with transparent tape and then folded and cut to produce a hole larger than the number 10 screw in the plotting board. This hole is not critical in size since the chart alignment on the plotting board is accurately determined from the ends of the north, south east, and west lines which were extended beyond the radius. A preliminary tallying of checkpoints on each orbit is necessary to determine that there is an adequate number and distribution to provide accurate flight track during the orbit checks.

310.3 Calibration. To minimize the error in estimation due to variances in course sensitivity, calibration should remain 150 *ua* to the 20th line and the OBS should be rotated every 10 degrees, thereby keeping the transition within 5 degrees of the centerline of the recording.

310.4 Procedure

a. As the pilot marks a checkpoint while conducting the orbit, he will call out the actual magnetic azimuth of the checkpoint. The recorder operator will insert this azimuth in the left-hand column of the worksheet on the back for Form ACA-1678.1, under the heading "CHECKPOINT AZIMUTH."

b. The recorder operator will also compute the azimuth as seen by the receiver, by counting the number of lines from the crossover on the recording. The value in degrees per line is equal to 0.5 degrees for a 20-degree course sensitivity. If the side-pen marks occur after the crossover (counterclockwise orbit), subtract the equivalent number of degrees from the OBS setting.

c. Insert on the worksheet the azimuth as seen by the receiver in the column headed "RECEIVER AZIMUTH" for the appropriate transmitter being checked at that time.

d. The recorder operator will subtract the azimuth taken from the map from the azimuth as read from the recorder, or vice versa. If the map azimuth is a higher value than the receiver azimuth, the error is POSITIVE. If the map azimuth is lower than the receiver azimuth, the error is NEGATIVE.

e. When computation is made that shows a station error greater than 2.5 degrees, the area in question should be probed radially to verify alignment and to record the vertical polarization component.

f. If a complete orbit check is flown on each transmitter, a comparison between transmitters should be made, and the amount of shift and direction can be indicated by plus or minus, comparing transmitter number 2 against transmitter number 1. This figure should be inserted in the column headed "XMTR SEP, + or -, 2 FROM 1."

g. If one orbit check is flown changing the transmitters every 20 degrees, the noticeable shift and direction should be inserted in the column as indicated above, under the corresponding OBS setting. Here it will be necessary to indicate which transmitter is in use at the time.

h. The maximum roughness and/or scalloping on each transition should be inserted under the appropriate transmitter opposite the indicated OBS setting.

SECTION 311

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*U.S. Government Printing Office: 1996 - 769-979

SECTION 311

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U.S. Department of Transportation

Federal Aviation Administration

Directive Feedback Information

Please submit any written comments or recommendations for improving this directive, or suggest new items or subjects to be added to it. Also, if you find an error, please tell us about it.

Subject: Order 8200.1A

To: Directive Management Officer, Mike Monroney Aeronautical Center (AVN-230)
P.O. Box 25082, Oklahoma City, OK 73125

(Please check all appropriate line items)

☐ An error (procedural or typographical) has been noted in paragraph ________ on page ________.

☐ Recommend paragraph ________ on page ________ be changed as follows:
(attach separate sheet if necessary)

☐ In a future change to this directive, please include coverage on the folowing subject
(briefly describe what you want added):

☐ Other comments:

☐ I would like to discuss the above. Please contact me.

Submitted by: ______________________________ Date: ______________

FTS Telephone Number: ________________ Routing Symbol: ________________

FAA Form 1320—19 (8-89)